Science and Mathematics Education Centre

Educating for Environmental Literacy: The Environmental Content of the NSW Science Syllabuses, Student Conceptions of the Issues and Educating for the New Global Paradigm

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

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ABSTRACT

This thesis reports a 2013 study that investigated the environmental literacy of NSW students, which was measured using a diagnostic questionnaire, developed by the author, the Australian Environmental Literacy Quotient (AELQ).

The goal of Environmental Education, now more commonly referred to as Education for Sustainability (EfS) or Education for Sustainable Development (ESD), is to develop in students an understanding of the underlying science of the interaction of humans with natural systems, but is more than mere scientific or technological knowledge about environmental issues. ESD has arisen out of the need to have students understand the interconnectedness of the current ecological, social and economic crises, and represents a new educational paradigm; one which challenges schools to fundamentally change the way they operate, as it pervades all aspects of school operations; curriculum, teaching and learning, physical surroundings and relationships with the local community. Environmentally literate students, educated in this new pedagogical environment, will have the skills, capacity and motivation to plan and manage change towards sustainability within an organisation, industry or community.

It cannot be expected that the formal education system, which in reality touches children for a fraction of their lives, can teach everything about living, working, and governing in a manner that will achieve sustainability for their community and nation. Schools must, however, develop in students sufficient levels of environmental literacy that they are able to understand connections between environmental, economic, social and political systems.

Environmental literacy, also known as eco-literacy, is a complex concept to define and measure, as it encompasses far more than scientific knowledge about environmental issues, but also attitudes, values and actions towards sustainable practices. Environmental literacy is considered to be the paramount objective of ESD programs.

This study critically examines the learning outcomes of the NSW Science syllabus content relating to environmental and ecological issues, and evaluates the success of

teachers implementing the NSW Science curriculum and *Environmental education policy* by assessing the environmental literacy of students.

The study used qualitative and quantitative methods of data collection to examine the levels of environmental literacy of 926 students in Stages 3, 4 and 5 in NSW schools. A measuring instrument was developed that assessed not only the students' knowledge of ecological concepts, but their awareness of and attitudes towards environmental issues. A key part of the instrument was the measurement of the range of sustainable behaviours the student was exposed to both at school and in the home.

In this thesis the author presents the results of the survey, and the correlations between the different dimensions of Knowledge, Awareness, Attitude and Action. The author did not find any significant correlation between knowledge and behaviour. Strongly positive attitudes towards the environment were moderately associated with environmental literacy, with the students' perception that environmental issues mattered to parents and teachers more strongly related to positive attitudes and higher environmental literacy in students.

The findings of the study suggest that the limited relevant content in the Science syllabuses and the ad-hoc nature of environmental practices in schools mean that the intended objectives of environmental education in NSW schools are not being achieved. The author calls for further research to refine the measuring instrument, investigate the longitudinal development of environmental literacy in NSW students and identify ways to improve the implementation of environmental education as the National Curriculum is introduced in NSW schools.

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GLOSSARY OF TERMS

Action Competence

Action competence is linked to the concept of change through participation in democracy. In this context, actions are not viewed as reactive behaviour or so-called lifestyle changes, but as the outcome of active democratic participation in society. The action taken is conscious, intentional and voluntary.

Action competence occurs when citizens:

- are committed, motivated and driven to make changes;
- have a critical and holistic knowledge of the issue;
- can envision a sustainable solution; and
- are experienced in taking successful concrete action.

Action competence is seen as a crucial outcome for Education for Sustainable Development because it combines the processes and practices of education with the need to develop democratic citizenship skills and values as well as an awareness of the ecological, social and environmental crises facing the planet.

Action Learning

Action learning is a process where reflection and assessment are used to reach the goal of improved practice.

The process involves the development of an action plan, which is then implemented. Participants then reflect on what they have learnt as a result.

A facilitator/mentor, such as a teacher, assists the participants in the development of their plan and reflection. The process works well in group settings where a number of people come together to critically reflect upon how their knowledge and experience can be used to improve practice.

Action research

Action research can be used as a collaborative research tool, which aims not just to improve, but to lead to innovative teaching practices.

It is often represented as a four-phase cyclical process of critical enquiry: plan formation, action/outcome, observation and reflection. Change is viewed as the desired outcome of action research and thus it can act as a catalyst for embedding change in systems, leading to sustainable practices.

Its focus on critical enquiry and continuous self-evaluation also makes it a useful tool for professional development in Education for Sustainable Development.

Adelaide Declaration

The *Adelaide Declaration* (April 1999) outlined a set of common and agreed directional National Goals by each State and Territory for schooling in the twenty first century.

Goal 1.7 states that when students finish their schooling they should "have an understanding of, and concern for, stewardship of the natural environment, and the knowledge and skills to contribute to ecologically sustainable development".

Capacity Building

Capacity building in ESD involves programs or initiatives supporting people through an educational process that builds the skills needed to engage in change towards sustainability. The building of skills can enhance the effectiveness of individuals, organisations and systems to define or achieve outcomes by strengthening their knowledge base, competence, resources, networks, infrastructure and other forms of support.

The process of capacity building may involve thinking systemically, challenging assumptions, critically questioning situations and articulating visions of the future. These skills are used to bring about

structural or institutional change within mainstream society by helping people to guide, direct, and empower themselves.

Carrying Capacity *Carrying capacity* is the term given to the maximum number of organisms that a given area of habitat can support indefinitely, without degrading the habitat or causing social stresses that result in population decline.

The term is often applied by those who have concerns about the ratio of the human population against available resources. However, this application is considered problematic since ethical beliefs and the use of technology add dimensions to the human situation that make it more than a straightforward calculation.

Citizen Science *Citizen science* is a participatory process that attempts to build public understanding of, and confidence in, science as well as support for scientific knowledge. It can be viewed as a process of social learning, relevant to all sectors, but particularly to school students.

Critical Thinking *Critical thinking* a process that involves questioning the world around us, how we shape society, and how we are shaped by society. This is a necessary process for Education for Sustainable Development because it can be used to interpret root causes of local and global problems, challenge biases, and support rational decision-making.

Eco-Efficiency The term *eco-efficiency* was coined by the World Business Council for Sustainable Development (WBCSD) in 1992 and is defined as the delivery of competitively priced goods and services that satisfy human needs and promote quality of life. Eco-efficiency progressively reduces ecological impacts and resource intensity throughout the life cycle of goods and services.

Ecological Footprint	The term *ecological foot-printing* was developed by Wackernagel and Rees in 1996. Ecological footprints essentially act as a measure of human impact on environmental systems, documenting the consumption and waste production of an individual, population or organisation. They are measured in terms of the area of biologically productive land, air and water required to produce the goods consumed and to assimilate the wastes generated in a single year. The ecological footprint is a valuable resource for environmental educators because it provides a means to compare: • various components of individual consumption • average consumption and impact patterns amongst countries/organisations • individual and world average impacts.
Ecologically Sustainable Development	*Ecologically Sustainable Development* aims to meet the needs of people today, while conserving our ecosystems for the benefit of future generations of all species. This term also refers to the path or framework followed in order to achieve sustainability.
Education *about* the environment	*Education about the environment* is the most commonly practiced approach in Environmental Education. It focuses on developing key knowledge and understanding about natural systems and complex environmental issues, as well as developing an understanding of the human interaction with these systems and issues.
Education for Sustainability (EfS)	*Education for Sustainability* refers to holistic and integrated Environmental Education that aims to motivate and equip individuals and social groups through learning for change. The process involves reflecting on how we currently live and work, making informed decisions, collectively addressing the issues and problems and

creating ways to achieve a more sustainable world.

More than a dissemination of knowledge, EfS seeks to develop the skills required to address sustainability; such as systemic thinking, critical thinking, and creativity.

Also known as *Learning for Sustainability* (LfS) and *Education for Sustainable Development* (ESD).

Education *for* the environment

Education for the environment moves beyond education *in* and *about* the environment approaches to focus on equipping learners with the necessary skills to be able to take positive action. The education *for* the environment approach promotes critical reflection and has an overt agenda of social change. It aims to promote lifestyle changes that are more compatible with sustainability.

It seeks to build capacity for active participation in decision-making for sustainability. In practice, however, education *for* the environment is often interpreted as the involvement of learners in one-off events or individual actions (e.g. tree planting) although occasionally this can trigger greater change on a social level.

Education *in* the environment

Education in the environment is an approach which provides opportunities for students to have direct experience in the environment and develop positive attitudes and values towards stewardship of the environment. The approach may foster a value-based environmental concern of the importance and fragility of ecosystems and landscapes. While ecological concepts may be taught through these explorations, the focus is on having positive experiences in a natural setting.

Environment and Schools Initiatives (ENSI)

Environment and Schools Initiatives is an international network of educators from 14 member countries across the OECD and under the umbrella of the OECD Centre for Educational Research and Innovation.

The ENSI cooperatively undertake Environmental Education action

research and development programs, particularly focusing on activities related to sustainability, by means of a participatory approach that involves schools, teachers, teacher trainers and students. ENSI also promotes international exchange, understanding and collaboration amongst network members and with other international organisations; it also makes policy recommendations when appropriate. Through research and the exchange of experiences, ENSI also supports educational developments that promote environmental understanding, active approaches to teaching and learning, and citizenship education.

Environmental Education (EE)

Environmental Education refers to the overall field of education that engages learners with their environments (be they natural, built or social) and to any process or activity that assists the development of awareness, knowledge, skills and attitudes leading to environmentally responsible practices and behaviour.

Approaches to EE have evolved significantly since the term was first used in the late 1960s. During the 1970s educators perceived EE as 'education *about* the environment' and focused on developing knowledge and understanding in students. EE then progressed to favour the approach of 'education *in* the environment', promoting experiences in outdoor settings. By the 1990s the practice of teaching 'education *for* the environment' emerged as a dominant paradigm, with its focus on participation and action to improve the environment. In the new century one can still find examples of all these approaches within the practice EE.

The most recent development in EE theory and practice is *Learning for Sustainability*, or *Education for Sustainable Development*. This approach challenges current practice in several ways to achieve more systemic change towards sustainability.

Environmental Education for a Sustainable Future: National Action Plan

The *National Action Plan* was a national Australian strategy launched in 2000 that outlined a direction for EE in Australia.

The plan aimed to:

- increase the profile of EE;
- implement a national coordinating body for EE to provide professional development opportunities for teachers and others involved in EE;
- develop resources for EE; and
- integrate EE into mainstream education and training activities.

The *National Action Plan* was updated in 2009.

Experiential Learning

Experiential learning is a constructivist approach to learning that uses contexts personally relevant to the participants in order to engage them in reflection, problem solving and decision-making. Participants are encouraged to actively construct their own knowledge, skills and values from direct experience. Experiential learning thus draws upon the knowledge of the learner, in addition to their understanding and prior experience, and involves the application of this knowledge to their current activities. This process also provides opportunities for debriefing; and the consolidation of ideas and skills through reflection and feedback; and the application of the ideas and skills to new situations and problems.

The experiential learning cycle involves four stages:

Experience: Engaging in a particular experience and observing its effects.

Processing the experience: Analysing and understanding actions, thoughts and feelings from the experience.

Generalising: Developing cause and effect relationships behind the

action or experience.

Applying: Applying the generalisations generated to new situations.

Experiential learning differs from action learning in that participants are engaged in a specific, predetermined experience, such as an outdoor or nature based activity, rather than relying on their past personal experience.

Learning for Sustainability (LfS)

Learning for Sustainability is a concept that has crystallized as a result of international agreements and the global call to actively pursue sustainable development. It builds on and provides a new orientation for past practices in Environmental Education. LfS attempts to move beyond education *in* and *about* the environment to focus on equipping learners with the necessary skills to be able to take positive action to address a range of sustainability issues.

LfS motivates, equips and involves individuals and social groups in reflecting on how we currently live and work; in making informed decisions; and creating ways to work towards a more sustainable world. Underpinned by the principles of critical theory, LfS aims to go beyond changing individual behaviour and seeks to engage and empower people to implement systemic changes.

Also known as *Education for Sustainability* (EfS).

Life Cycle Analysis (LCA)

Life Cycle Analysis is a technique for quantifying and assessing the inputs and outputs affecting environmental performance associated with a product throughout its life cycle from production, through use, to disposal. LCA can assist in identifying opportunities to improve environmental performance.

National Environmental Education

A key element of the Australian Government's National Action Plan for Environmental Education is the establishment of the *National Environmental Education Council*. The Council is a non-statutory

Council (NEEC)	body comprised of people from a variety of sectors who provide expert advice to the Government on EE issues. A key goal of the Council is to raise the profile of EE and, in particular, how Australians can move beyond environmental awareness to informed action.
Natural Resource Accounting	A system used in accounting that deals with stocks and stock changes of natural assets, made up of biota, proved reserves of subsoil assets, water (aquatic ecosystems) and land (terrestrial ecosystems). This allows data to be transformed into a form that is comparable to that used to describe the economy.
Precautionary Principle	The *precautionary principle* approach states that in the absence of scientific consensus that a policy or action will cause harm to the environment, the burden of proof that it is *not* harmful falls onto those taking the action. The principle implies there is a social responsibility to protect the environment and people from exposure to harm.
Sustainability and Sustainable Development	An evolving concept, the idea of *sustainability* developed out of the *World Commission on Environment and Development* (WCED), set up by the United Nations in 1983. The idea of sustainability involves conserving the vitality and diversity of the Earth, as well as an improving quality of life for present and future generations. It carries within it notions of social justice, healthy economies and thriving societies and addresses issues such as food security, poverty, sustainable tourism, urban quality, women's rights, fair trade, green consumerism, ecological public health and waste management; as well as climatic change, deforestation, land degradation, desertification, the depletion of natural resources and loss of biodiversity. Sustainability implies changes in behaviour and practices by individuals and organisations.

Systems/ Systemic Thinking	*Systems thinking* is a broad, interdisciplinary thinking methodology based upon a critical understanding of how complex systems, such as environments and ecosystems, function by considering the whole rather than the sum of the parts. Systems thinking is an alternative to the current dominant way of thinking which emphasises analysis and understanding through deconstruction. *Systemic thinking* offers a better way to understand and manage complex situations with its emphasis on holistic, integrative approaches, because it takes into account the relationships between system components and works toward long-term solutions critical to addressing issues of sustainability.
Tbilisi Declaration	The *Tbilisi Declaration* developed in 1977 under the auspices of the UNESCO and United Nations Environment Program (UNEP), and outlined specific objectives for the implementation of EE.
Triple Bottom Line	The term *triple bottom line* can be used as a framework for measuring and reporting on the performance of organisations against economic, social and environmental parameters. More broadly, the term is used to capture the whole set of values, issues and processes that an organisation needs to address in order to minimise any harm resulting from its activities and to create economic, social and environmental value.
UN Decade of Education for Sustainable Development (UNDESD)	Resolution 57/254 was adopted by the United Nations General Assembly in December 2002, establishing the *United Nations Decade of Education for Sustainable Development (2005-2014)*. Previous initiatives focussed on sustainability included the *Earth Summit*, *Agenda 21* and the *World Summit on Sustainable Development*. The Decade presents the most comprehensive

opportunity yet to focus world attention on LfS across the globe.

The DESD aims to:

- promote education as a prerequisite for the movement to sustainable human societies;
- integrate the concept of sustainable development into education systems at all levels; and
- strengthen international cooperation towards the development and sharing of innovative ESD theory, practice and policy.

The DESD also offers opportunities for education policy-makers, researchers and practitioners to join in partnerships that contribute to a collective and international imperative.

Values Clarification

Values clarification is an educational approach that employs a variety of strategies to enable learners to clarify and critically examine their own values, particularly those that are unconscious or unspoken.

This process helps learners uncover how culture, ideology, gender, socio-economic background and religion shape deeply held personal beliefs and values, while assisting learners in determining how their values coincide or conflict with others.

Whole-school Approaches

Whole-school approaches to sustainability incorporate all elements of school life including school governance, pedagogical approaches, curriculum, resource management, school operations and grounds. Whole-school approaches can also encompass links and/or partnerships with the local community.

World Education Forum

The *World Education Forum* was held by the United Nations in Dakar, Senegal in 2000. The outcome of this forum was *The Dakar Framework* which reaffirmed a commitment to achieving basic quality education for all by 2015 and entrusted UNESCO with

coordinating and sustaining global momentum towards this aim.

World Summit on Sustainable Development (WSSD)

and Johannesburg Plan of Implementation

The *World Summit on Sustainable Development* was held in Johannesburg, South Africa in 2002. The core goal of the summit was to review the progress made towards sustainability in the ten years since the 1992 *UN Conference on Environment and Development (UNCED)* in Rio. The focus of the summit was on the status of the implementation of *Agenda 21*, identifying further measures required to implement the Rio agreements, areas where more effort was needed and new challenges and opportunities.

The *WSSD* reaffirmed commitment to the Rio principles, the implementation of *Agenda 21* and to the development goals adopted in the *UN Millennium Declaration*. An outcome of the summit was the production of the *Johannesburg Plan of Implementation*, which was a targeted action plan containing more than 120 targets for sustainable development in conjunction with other UN-sponsored principles.

The *Johannesburg Plan of Implementation* pointed to the social actions required to achieve sustainable development and to the role of education, capacity building and communication in achieving this goal. It recommended the adoption of the UN Decade of Education for Sustainable Development to further opportunities to implement sustainable development.

CHAPTER 1

INTRODUCTION

1.1 Introduction

The *Melbourne Declaration on Educational Goals for Young Australians* (2008) aimed to see young Australians becoming "active and informed citizens [who] work for the common good, in particular sustaining and improving natural and social environments" (p. 7). As part of its commitment to the UN Decade of Education for Sustainability, the Australian Government developed a vision, goal and strategy to foster sustainable development through education over the years 2005 - 2014 (*Caring for Our Future*, 2007) and in the *National Action Plan* of 2009 aimed to "equip all Australians with the knowledge and skills required to live sustainably" (p. 4). In NSW, the 2001 *Environmental education policy for schools* aimed to support effective environmental education programs in government schools in the state.

All Australian students study science as part of the curriculum. The concept of environmental literacy is not overtly defined and to date has not been measured in Australia. As a result, there is as yet no way to determine if NSW students are meeting the environmental education goals defined in the *Environmental education policy for schools,* the *NSW Science Syllabus* and the *National Curriculum*.

This project aimed to critically examine the NSW Science Syllabus content relating to environmental and ecological issues. The environmental literacy of school students was then measured using a diagnostic questionnaire. Finally, the efficacy of the syllabus content in informing the students was assessed.

1.2 Historical Background

Humans have reached a point where, through population growth and our use of technologies, we are no longer just one of the millions of species inhabiting the planet; rather we are active agents of chemical, physical, biological and geological change.

The *Ecological Footprint Atlas* reported that in 2008 the average ecological footprint for Australians was about 7.1 hectares; better than that of the average North American at 9.6 hectares, but far higher than Asians or Africans (less than 1.4 hectares per person). At a world average of 2.3 hectares per person, humanity has exceeded the Earth's biological carrying capacity of 1.9 hectares per person. The planet simply cannot continue to sustain this rate of consumption of renewable resources.

Furthermore, Australia's green credentials are not as good as we might like to think. The Centre for Environmental Law and Policy's 2012 *Environmental Performance Index* ranked Australia 48th out of 132 nations - behind countries such as New Zealand, Sweden, Finland, Czech Republic, Austria, Costa Rica, Britain, Denmark, Japan, Belgium, Canada, Malaysia and Ireland in terms of water consumption, air quality, sustainable energy and biodiversity protection. The 2011 *State of the Environment* report identified a range of pressures on the Australian environment, including:

- the degradation of land and waterways;
- population growth and the associated problems of urban sprawl, high energy consumption, storm water pollution; and
- biodiversity decline due to land clearing, loss of natural habitat and the introduction of pest species to terrestrial and marine ecosystems.

All citizens, as consumers, workers, parents and community members, make decisions that have implications for natural systems. What we eat, what we wear, how we transport ourselves, heat our homes, our recreational activities and the goods we choose to own all have significant impacts on the environment. We need to understand the implications of our choices, rather than continuing to do unnecessary damage through ignorance. Anyone who wishes to engage seriously with an environmental issue for the purposes of decision making or action will need to learn some of the relevant science.

Therefore, an understanding of fundamental ecosystem processes such as the water cycle, the mineral cycle, energy flow and succession; together with key eco-concepts such as climate change, sustainable water, the processes that lead to land degradation, salinity, biodiversity, and human impact on the environment are the central content

concepts of environmental literacy, providing a knowledge base that can be taken into consideration when making decisions. Students should thus acquire both a basic knowledge of their local environment and a general understanding of complex systems.

Science can be a problematic source of advice for everyday life; as it is often fraught with controversies, new findings and divergent interpretations. Some major environmental problems are known to be the direct result of scientific and technological innovation. Obvious examples are the past use of CFCs, DDT and PCBs. Others such as non-biodegradable oil-based plastics, intensive land use, and nuclear power may be considered by some to have acceptable risks or positive benefits that outweigh the negatives. More confusing for the lay-citizen is that scientific knowledge about such issues is frequently called into play to protect the interests of commercial or political powers. Thus, the relationship of lay-citizens and other non-experts to science is a complex one. Most people will take so-called 'expert' advice and integrate it with their individual 'common sense' knowledge. The science may, for a variety of reasons (including self-interest), be rejected. The validity of such other forms of knowledge cannot be readily judged by conventional scientific norms and cannot easily be thought of in terms of a cognitive deficit model of knowledge, i.e., what people don't know.

Stuckey, Hofstein, Mamlok-Naaman and Eilks, (2013) have analysed how ideas around what constitutes 'relevant' learning in science have changed over the decades, concluding that one of the key goals of science education should be that it involves learning that is relevant for both the student and the society he or she lives in. Burmeister, Rauch and Eilks (2012) have emphasised the importance of science education to sustainable development in the future, while Roth and Lee (2004) feel it is essential that citizens develop science-based skills if they are to participate actively in societal issues. De Haan (2006) concurs that only learning which brings together the social, economic and ecological aspects of science will ensure students are equipped to meet the goals of Education for Sustainable Development (ESD).

For many people, active engagement with environmental science begins with their involvement with a problem they become engaged with. A parent is concerned with what type of bottle to buy for their newborn child and begins to read on-line forums in

order to understand why they hear they should only buy BPA-free. Shoppers are confused as to what they hear about using green supermarket bags from the media. They assumed they were 'eco-friendly', now they are told they are not. What Jenkins (2003) refers to as 'citizen thinking' is "much more complex and less understood than scientific thinking" (p. 438).

The self-evident problem of having environmentally illiterate citizens make decisions around complex problems linked to sustainability mean that ESD, and thus environmental literacy, must now be considered fundamental components of a basic education, perhaps even *more* important than scientific or technological literacy. It is impossible for the average citizen to separate an environmental problem framed in scientific terms from wider concerns. Personal concerns and institutional factors, such as the political, social and economic, are intertwined with the scientific. The challenge is to reach outcomes which support an integrated whole. Thus, ESD needs to address the relationship between scientific knowledge, authority and the public and, as a result, constitutes a challenge to the traditional subject-based curriculum, demanding new approaches to both teaching and assessment.

As an example; the United Nations Food and Agriculture Organization (2008) has identified livestock production as one of the three most significant causes of environmental problems. Livestock not only occupy a fourth of the world's land area and eat a third of its grain, but also produce 18 percent of the world's anthropogenic greenhouse gas emissions, including 37 percent of methane emissions and 65 percent of nitrous oxide emissions. This is a problem not only well within the scope of the understanding of primary school children, but one where personal choices can have a significant impact. Yet there currently exists little scope within the mainstream curriculum to examine such a complex system covering aspects of economics, consumption and lifestyle patterns, equality and social justice, animal rights and consumerism.

Environmental concepts, and all the associated skills, values and behaviours which develop environmental literacy, have to be taught as a *process*, rather than just a body of

knowledge; because science *itself* is not an immutable body of knowledge, but the process of trying to understand the natural world and the impact of humans on it.

In order to try to establish where students are obtaining and implementing their eco-knowledge, they will be surveyed about their knowledge, awareness, attitudes and practices at home and school. It is hoped this study will be able to demonstrate which aspects of current practices in environmental education are 'working' and which are not. Are the formal aspects of the curriculum having the biggest impact on students' environmental literacy, and thus their behaviour and attitudes, or are the more informal aspects of their education, such as family attitudes and behaviours (composting, recycling, purchasing decisions), or school practices (worm farms, policies such as 'nude lunch' days, kitchen gardens, water tanks) having the greater impact?

The implications for the relationship between ESD and environmental action by informed citizens are profound. Environmental problems are too complex to be simply a matter of applying learned knowledge. Curriculum content may need to be intensively local, as well as global. Units of work may need to allow for an in-depth examination of a natural cycle, rather than the piecemeal approach currently suggested by syllabuses, such as the NSW Science syllabus. Teaching strategies will need to be enquiry-based, student-centred and interactive. The scientific knowledge encountered in the classroom will need to be reworked and integrated with other kinds of knowledge if it is to be of practical use. It is hoped that this study may shed some light on these areas.

1.3 Aims and Objectives

This thesis aimed to evaluate the effectiveness of the NSW Science Syllabus and the *Environmental education policy for schools* in developing adequate levels of environmental literacy in NSW school students in Stages 3, 4 and 5. As we approach the end of the UN Decade of Education for Sustainable Development, it is pertinent to ask if the goals of the *Melbourne Declaration*, the *National Action Plan*, the *Sustainability Curriculum Framework*, the NSW Science Syllabuses and the NSW *Environmental education policy for schools* are having any impact on the environmental literacy of students.

More specifically, the research questions of the study asked:

1. Are the current NSW science syllabuses and educational policy documents supporting the development of environmental literacy in NSW students?
2. How is environmental literacy to be defined and measured?
3. What is the measureable level of environmental literacy of Stage 3, 4 and 5 students for each of the variables; knowledge, attitude, awareness and action?
4. Do the sustainability practices of the school contribute to students' values and attitudes towards environmental issues?
5. Do the sustainability practices in the home have a greater influence on the values and attitudes towards environmental issues than the practices at the student's school?

The specific objectives of the study were:

1. to critically evaluate the content of the NSW Science syllabus to determine if key areas of eco-literacy are included;
2. to develop a measuring instrument that can be used to measure the environmental literacy of students by assessing their levels of knowledge, and attitudes towards and awareness of sustainable practices;
3. to measure the environmental literacy levels of students over several Stages of schooling;
4. to evaluate the impact of sustainability practices of home and school on the environmental literacy levels of students.

The research hypothesis was that NSW students are not developing sufficient levels of environmentally literacy to prepare them as citizens concerned about a sustainable future, and that the influence of the home environment plays a greater role in developing eco-literacy than the school culture.

This study was based on the theoretical frameworks developed in previous attempts to measure scientific literacy, particularly the Programme for International Students

Assessment (PISA) and the National Science Foundation (NSF). These frameworks are used to assess the attainment of various aspects of scientific literacy and have been adapted to measure content specific to environmental literacy.

Additional items in the measuring instrument were developed in an attempt to measure affective aspects (i.e. values and attitudes) of students towards environmental issues. The growing body of evidence in the literature tends to suggest that positive values and attitudes do not always lead to the adoption of sustainable practices and are not linked to greater functional eco-literacy.

It is hoped that the study will provide new information about the development of students' understanding of environmental issues as they move from Primary to Secondary studies, leading to a greater understanding of why and when environmental literacy develops. It is likely to have implications for teaching practice by highlighting which aspects of environmental literacy have developed in students, which may give teachers feedback about which approaches have had the greatest impact. It should give some insight as to efficacy of the environmental content of the science syllabuses in informing students' environmental literacy, as opposed to more informal ways of learning, such as implementing school and home-based eco-practices. These last two points may be useful to teachers developing teaching programs to meet the aims of the Science syllabus as the new National Curriculum begins to impact on schools.

1.4 Significance

The author has been unable to find any study of this size which has measured the environmental literacy of Australian students. By providing instrumentation, baseline data and subsequent comparative data on environmental literacy, this study provides findings to use in further studies.

The results of this project contribute significantly to the field, by adding to the body of knowledge around some of the questions which have been on the mind of environmental educators. Does the amount of content about environmental issues in the syllabus equip students to become environmentally literate citizens at this critical time? Are the values

and attitudes associated with environmental literacy being developed in students? Are the efforts of schools in modelling sustainable practices having any impact on students? How can teachers improve their efforts?

In recent years a range of small and medium studies measuring environmental literacy in students from primary school to university level have been undertaken in countries as diverse as Mexico, England, Korea, Lebanon, Malta, Chile, Bangladesh, the Netherlands, Turkey, Israel, Spain, France, Italy and the United States. Such studies are contributing to a picture showing how behaviour, attitudes and knowledge correlate within environmental literacy. Nonetheless, the literature also suggests that culturally specific measuring instruments are needed. Thus this study contributes at the international level, but also represents the first attempt within Australia to develop a measuring instrument to assess the environmental literacy of Australian students.

By providing data to schools and the NSW Department of Education and Communities, teachers and researchers will be able to measure, target and track students and learning environments as they begin to implement the new National Curriculum in addition to the existing policies underpinning Environmental Education in this country.

1.5 Thesis Overview

Included in Chapter 1 is an introduction to the thesis, together with an historical background, the aims and objectives of the thesis, as well as its limitations and significance.

The Literature Review is presented over three chapters. Chapter 2 examines the literature pertinent to Education for Sustainable Development. This includes a summary of the evolution of the concept of Environmental Education (EE) since the idea first emerged in the 1970s; the United Nations Decade of Education for Sustainability; and the emergence of Education for Sustainable Development as a new educational paradigm. The development of EE policy in Australia and the implementation of these concepts into our curricula are also discussed. Finally, an evaluation of the content in

the NSW Science Syllabuses relating to EE is given in order to demonstrate where students currently encounter EE in the curriculum.

Chapter 3 examines the various aspects of learning theory related to EE/ESD, along with the role of teacher training in EE, and the various ways EE/ESD is being implemented into schools. The concept of eco-literacy is defined and discussed in Chapter 4, along with the ways it is beginning to be measured.

The research design and the quantitative and qualitative methodology used in this study are outlined in Chapter 5, together with the objectives this thesis addresses. The rationale behind the design of the measuring instrument is described. The composition of the research sample, methods of data collection and treatment are outlined. Procedural processes used in handling the data to determine the *Australian Environmental Literacy Quotient* (AELQ) are also described.

Chapter 6 presents the results from the use of the measuring instrument. The findings of the survey are given, and comparisons outlined between the stages of schooling, the schools involved and the four scales used in the measuring instrument. The survey results are used to define bands within the AELQ, so that the environmental literacy of students can be qualitatively and quantitatively assessed. Reflections on the method are presented.

In Chapter 7 the findings and conclusions from the study are drawn together with reference to the research questions. This chapter also discusses the implications of this study for schools and teacher training, together with suggestions for future studies.

Appendix A contains the consent form given to participants in the study, while Appendix B shows the survey instrument used in this thesis.

1.6 Limitations

This thesis represents the first attempt to quantitatively measure the environmental literacy of school students in Australia, and as such is small in scale and scope. Many of the limitations placed on this thesis arose from these constraints.

Seventeen schools in the author's locality were invited to participate, but some principals were unwilling to consider involvement. Twelve schools were recruited to assist, but only ten schools were able to make the final arrangements and participate.

The need to obtain informed consent meant that teachers had to be willing to hand notes out to all students, and to chase up their return. Some teachers were unwilling to 'cast the net' widely, expressing concern that some students would not take the survey seriously, and tended to self-select classes and students they felt would give 'quality' results. This not only resulted in smaller than desirable sample sizes in some schools, but also meant the sample is not as random as would have been preferred.

Time and personnel constraints meant that a large pilot study was not able to be conducted, open-ended questions and interviews were unable to be considered and the survey had to be limited in scope and size so as to be manageable during the available time, usually a single school period.

Nonetheless, the discussion and analysis of the results obtained indicates that this thesis provides a sound baseline snapshot of the environmental literacy of NSW school students and presents findings which have important implications for policy and practice around Education for Sustainable Development in Australian schools.

CHAPTER 2

EDUCATION FOR SUSTAINABLE DEVELOPMENT

2.1 Introduction

> There can be few more pressing and critical goals for the future of humankind than to ensure steady improvement in the quality of life for this and future generations, in a way that respects our common heritage – the planet we live on. As people we seek positive change for ourselves, our children and grandchildren; we must do it in ways that respect the right of all to do so. To do this we must learn constantly – about ourselves, our potential, our limitations, our relationships, our society, our environment, our world. Education for sustainable development is a lifewide and lifelong endeavour which challenges individuals, institutions and societies to view tomorrow as a day that belongs to all of us, or it will not belong to anyone.
>
> UNESCO (2005a, p. 8)

This literature review describes previous research on Environmental Education (EE) and Education for Sustainable Development (ESD). Environmental issues are considered within the context of the development of EE, the development of policy and curricula and current teaching, learning and cognitive theories. Despite a significant body of research about ESD the growing importance of this emerging field indicates the need for continued research. In particular, there have been no attempts in Australia to measure the environmental literacy of students, hence the significance of this thesis.

Chapter 2 examines the literature that is pertinent to ESD. This includes a summary of the evolution of the concept since the idea of EE first emerged in the 1970s, developed into Education *about* the Environment, then Education *in* the Environment, Education *for* the Environment, then into Learning for Sustainability, and finally, with the United Nations Decade of Education for Sustainability, the emergence of Education for

Sustainable Development as a new educational paradigm. The development of EE policy in Australia and the implementation of these concepts into our curricula are also discussed in this chapter.

2.2 The Development of Education for Sustainable Development

2.2.1 Evolution of the Concept of Environmental Education

The history of Environmental Education (EE) in Australia is linked with concurrent global movements. As EE has evolved from nature studies, through education *about*, *in* and *for* the environment, to sustainability education the development of EE in Australia has mirrored what has occurred on a global level. The terms EE, Education for Sustainability and Education for Sustainable Development are often used concurrently and interchangeably, although differences between these terms do exist, and will be elaborated upon as necessary.

Jenkins (2003) has outlined how during the latter half of the twentieth century, the idea of 'environmental education' gained momentum, with early notions of 'nature studies' and 'conservation' broadened to embrace concepts such as 'stewardship', 'globalisation' and 'sustainable development'.

The term EE first appeared in the USA and the UK in the mid-1960s. In March 1965 at a conference at the University of Keele it was agreed that EE "should become an essential part of the education of *all* citizens, not only because of the importance of their understanding something of their environment but because of its immense educational potential in assisting the emergence of a scientifically literate nation" (Wheeler, 1975, p. 8).

In Australia, the first national conference specifically focused on EE was convened by the Australian Academy of Science in April 1970. Sir Otto Frankel, the chair of National Committee for the International Biological Program, noted that the deterioration of the environment threatened to engulf the whole world and concluded that this "is now perhaps the most pressing and most important aspect of education for

the coming decades" (Frankel, 1970, p. 8). Boyden (1970) placed educational institutions at the top of a list of key groups to be involved in EE, expecting them to provide students with an awareness of the threats to the human species by stimulating thinking and discussion on the social and biological problems of humankind, cautioning that teachers must avoid implying "that all the answers to any problems that man may have lie simply in further intensification of scientific and technological effort" (p. 19).

EE was first introduced into the Australian curriculum in the 1970s (see Table 2.1), but debate about its place within the curriculum has meant it has struggled to find a specific niche within mainstream curricula. Gough (1997) has outlined how the debate has tended to focus on whether EE should be incorporated as content, or as a process. If taught as content, should it be a separate course, or a cross-curricula theme, or perhaps a combination of both? The cross-curricula approach has evolved and is now favoured by most because, due to the holistic nature of EE, it naturally has an interdisciplinary focus.

The concept of Education for Sustainability (EfS) crystallised in the late 1980s when world leaders agreed that sustainable development was to be pursued as a key global goal and that education was an important tool in achieving sustainability. In 1992 the United Nations Conference on Environment and Development (UNCED) was held. It was also known as the *Earth Summit* or *Rio Summit*. From this point, the term Education for Sustainable Development (ESD) emerged because "education is critical for promoting sustainable development and improving the capacity of the people to address environmental and developmental issues." (UNCED, 1992, Chapter 36).

During the last decades of the twentieth century there was international evidence that these ideas were filtering into education. In 1986 the *Environment and School Initiatives* (ENSI) group was formed, with 13 full member countries and a number of partners. The *Foundation for Environmental Education* (FEE) supported the *Eco Schools* movement, which became firmly established in European and South African schools. Fifty countries are involved to date, although Australia is not among them. In 1995, ENSI came under the umbrella of the Organization for Economic and Cooperative Development-Centre for Educational Research and Innovation (OECD-CERI). Closer

to home, New Zealand began the *Enviroschools Programme*, while in China *The Green Schools Program* (Wu, 2002) was developed by the Centre for Environmental Education (CEEC), with other *Green Schools* found in India, Cyprus, Sweden and Thailand.

At the heart of all these initiatives was the idea of schools working outside their physical boundaries and using the resources of other groups and individuals. *The Dakar Framework for Action*, released by UNESCO after the World Education Forum, held in 2000, recognised that ESD would mean a substantial re-orientation of school curricula and that this would need to be supported by the learning for sustainability approach.

The importance of EfS/ESD was reaffirmed at the World Summit for Sustainable Development in Johannesburg (2002). Such gatherings helped to define EfS/ESD as a lifelong cycle of learning, action and reflection involving all citizens.

2.2.2 The Decade of Education for Sustainable Development

> The overall goal of the DESD is to integrate the values inherent in sustainable development into all aspects of learning to encourage changes in behavior that allow for a more sustainable and just society for all.
>
> UNESCO (2005a, p. 5)

Since the concept of sustainability first became linked with education there has been much discussion about what sustainability means. Most definitions seem to cover the idea of striving for ecological sustainability, but the subtext of an improving quality of life for present and future generations carries with it notions of social justice, the economic triple bottom line, and empowered citizens.

The United Nations uses sustainability and the concept of sustainable development as an over-arching paradigm to address numerous interrelated challenges including social, economic and cultural change and, most especially, economic development. The UN describes education as the "primary agent of transformation towards sustainable development" (2005a, p. 17), "a life-wide and life-long endeavour which challenges

individuals, institutions and societies to view tomorrow as a day that belongs to all of us, or it will not belong to anyone" (p. 8).

In 2005, the United Nations declared 2005-2014 as the Decade of Education for Sustainable Development (DESD). ESD is therefore a key concept for education in the new millennium, bringing a distinctive orientation to many important aspects of education, including access, relevance, equity and inclusivity. At its core, sustainable development is about relationships between people, and between people and their environment. In other words, it is a socio-cultural and economic concern.

Gough (2006) has pointed out that at the simplest level, EE and ESD share the same goal – enabling learners to question unsustainable practices and participate in changing these practices. The difference is in both the scope and focus of each approach. EE has traditionally been focussed on solving environmental problems. ESD encompasses EE, but is far more than teaching knowledge and principles related to sustainability. Rather, it is education for social transformation, and as such is set in a far broader context of socio-cultural factors and the socio-political issues of equity, poverty, democracy and quality of life. It is closely linked to social and economic development, but with the additional aim of creating more sustainable societies. ESD and EE both encourage critical thinking, values analysis and active citizenship in environmental contexts, but Fien (2001a) believes ESD is ultimately "about education and capacity building and only secondly about environmental problem-solving" (p. 19). In this sense, EfS/ESD touches every aspect of education; curriculum, teaching, learning and assessment, planning, policy, administration and finance.

Australia's response to the DESD began to be planned under the leadership of the NSW branch of the Australian Association for Environmental Education (AAEE), which organised seminars in 2002 and 2004 to raise awareness about the Decade and to seek national input into the World Summit draft documents, and the draft international implementation plan. A ten-year vision for Australia was also to be developed.

In 2005, the Victorian Association for Environmental Education (VAEE) organised a DESD forum and invited the Australian Government to present its preliminary plans for the Decade. The NSW Government, in co-operation with AAEE, also facilitated a one day workshop in November 2005 to celebrate the Decade and identify a vision for the Decade in NSW. In Western Australia, similar workshops were held throughout 2005, facilitated by Department of Environment and Conservation and Water Corporation to explore collaborative opportunities (Tilbury, 2006).

In 2005 a national symposium was held by the Australian National Commission and representatives from the regional UNESCO Office, responsible for Asia Pacific documents, were invited to contribute. The Final Report from the symposium (National Commission for UNESCO, 2005b) identified the need to integrate sustainability into state and territory institutional education plans at all levels and across all sectors by 2014. Priority was given to the inclusion of sustainability into education plans, rather than the development of specific DESD activities or programs.

As a result of these forums and also arising out of the *National Action Plan* for EE (Environment Australia, 2000), it was determined that three key mechanisms would implement the Government's initiatives in ESD for the Decade. The *National Environmental Education Council* (NEEC) was formed as an expert advisory body to the Minister, to assist in setting priorities in ESD. The *National Environmental Education Network* (NEEN), with representatives from Commonwealth, State and Territory environment and education agencies was to coordinate activities. This forum had a significant role in the development of the *Australian Sustainable Schools Initiative* (AuSSI) and the national ESD policy statement for Australian Schools, *Educating for a Sustainable Future* (Department of the Environment and Heritage, 2005). Finally, the *Australian Research Institute in Education for Sustainability* (ARIES) was established to undertake EfS/ESD research aimed at promoting improved environmental practice in the Australian community in support of sustainable development.

The Australian Government's strategy for the UN DESD was outlined in *Caring for Our Future* (Department of the Environment and Heritage, 2007), while priority actions were

identified in *Living Sustainably, the Australian Government's National Action Plan for Education for Sustainability* (2009). These documents are discussed further in Section 2.3.

In summary, Table 2.1 outlines a timeline of the development of the concept of EE. The DESD is now close to an end. Its stated aims included raising the profile of EfS/ESD, as well as providing further opportunities for people from all sectors to learn and participate in change for sustainability. During the Decade, the UN hoped to improve the quality of education through reorienting education goals, for example, by setting high standards in ESD and the eight *Key Action Themes* of Gender Equality; Health Promotion; Environment; Rural Development; Cultural Diversity; Peace and Human Security; Sustainable Urbanisation; and Sustainable Consumption (UNESCO, 2004). Tilbury (2006) warned that "if the Decade means 'business as usual' for those already engaged in ESD, then opportunities will be missed" (p. 80). This reorientation and transformation is seen by the UN as one of the world's greatest priorities, but, as Tilbury warned, Australia appears to have been left behind by nations such as China, New Zealand, Canada and the United Kingdom who have developed national frameworks in order to rework school education frameworks towards sustainability.

2.2.3 Education for Sustainable Development

> The recurring theme is that education for sustainability is essentially process driven, is participative and empowering, is liberatory and continuous, and that it is necessitated by the possibilities and dangers represented by an emerging 'postmodern' world.
>
> Sterling (1996, p. 14)

UNESCO is quick to differentiate ESD from EE, defining the latter as a discipline which "focuses on humankind's relationship with the natural environment and on ways to conserve and preserve it and properly steward its resources" (UNESCO, 2005a, p. 18).

Table 2.1

Key Events in the History of Environmental Education

Year	Australia	Internationally
1970	The first **Environmental Education** conference in Australia was hosted by the Academy of Science.	
1973		First **World Environment Day** held.
1975		As a result of the International Workshop on Environmental Education **The Belgrade Charter** was adopted and outlined the first framework and guiding principles for global environmental education.
1977		The **Tbilisi Declaration** developed under the auspices of the UNESCO and United Nations Environment Program (UNEP) outlined specific objectives for the implementation of environmental education.
1979	The **Australian Association for Environmental Education** was formed. Various state groups were established soon after.	
1987		The **Brundtland Commission** released the **Our Common Future** report, which first defined the term *sustainability*.
1991		The phrase *triple bottom line* was first used (Elkington, 1997).
1992		The United Nations Conference on Environment and Development (UNCED) held in Rio, also known as the **Earth Summit**, prepared a framework for international action known as **Agenda 21**. Chapter 36 entitled "Promoting Education, Awareness and Training", called on nations to integrate EE throughout all levels and sectors of society.
1993	**Agenda 21** was enshrined in law in Australia.	

1999	The Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) endorsed the **Adelaide Declaration** on National Goals for Schooling in the Twenty-First Century.	
2000	The **Environmental Education for a Sustainable Future: National Action Plan** (NAP) was released and the **National Environmental Education Council** (NEEC) was established.	The **World Education Forum** was held in Senegal. The outcome was **The Dakar Framework** which reaffirmed a commitment to achieving basic quality education for all by 2015 and entrusted UNESCO with coordinating and sustaining global momentum towards this aim.
2001	The NSW Department of Education and Training released its **Environmental education policy for schools**	
2002		The UN held the **Johannesburg Summit** (World Summit for Sustainable Development).
2004	The NSW Council on Environmental Education's **Environmental Education Research Conference** was held.	UNESCO declared the 2005–2014 **Decade of Education for Sustainable Development**.
2005	A Decade for Education for Sustainable Development UNESCO meeting was held in Melbourne and the **National Environmental Education Statement for Schools** was released.	
2008	The Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) endorsed the **Melbourne Declaration on Educational Goals for Young Australians**, which set the direction for Australian schooling for the next 10 years.	

Tilbury (1995) concurs, and argues that ESD has a sharper focus on developing closer links between environmental quality, ecology and the political threads underlying socio-economics. ESD thus encompasses EE, setting it in the broader context of the socio-political issues of democracy, equity, poverty and quality of life. The wide-ranging nature of the goals of sustainable development means that ESD cannot be taught as a discrete subject, but must be integrated into existing disciplines, with a deeper integration between the study of the environment and development problems. Gough

(2006) sounds a note of caution that the definition of ESD not be narrowed to merely become with interchangeable with EE and mean to "education for (environmental) sustainability" (p. 4).

Why is education considered to be an integral part of strategies for sustainable development? UNESCO (2004) believes that education plays a major role in enabling students to understand themselves and their links with the wider natural and social environment. Education is therefore the primary agent of transformation, fostering the values, behaviour and lifestyles required for a sustainable future so that "along with a sense of justice, responsibility, exploration and dialogue, ESD aims to move us to adopting behaviours and practices that enable all to live a full life without being deprived of basics" (UNESCO, 2004, p. 5). This is, however, "transformative education" (p. 16) that will bring about fundamental changes, inspiring "the belief that each of us has both the power and the responsibility to effect positive change on a global scale" (p. 17).

ESD must therefore have the following characteristics:

- be taught in an interdisciplinary and holistic way, and be embedded into the whole curriculum, not as a separate subject;
- explicitly examine, debate, test and apply the assumed shared values and principles underpinning the concept of sustainable development;
- use critical thinking and problem solving approaches to develop confidence in students that they can address the challenges of sustainable development;
- have teachers and students work together using a variety of different pedagogies to acquire knowledge and take a role in shaping the environment of their education institutions. Critically, students must participate in decisions about how they are to learn;
- be locally relevant and applicable so that the learning experiences are integrated into day-to-day professional and personal life, and address both local and global issues, using the language which learners most commonly use; and

- use a variety of different pedagogies, which model the process, such as word, art, drama, debate and experience. Teaching needs to be recast in an approach where teachers and students work together to not only acquire knowledge, but to play a role in reshaping the environment of their educational institutions.

ESD calls for a dramatic re-orientation of educational approaches, from policy to curriculum, content, pedagogy and assessment. Furthermore, ESD is not just confined to schools, but encompasses non-formal learning, community-based organisations, the workplace, technical and vocational training, teacher training, higher education educational inspectorates and policy-making bodies. The pedagogical approaches to EfS/ESD are detailed in Section 3.1, but the main components that inform this approach are outlined in Table 2.2.

Table 2.2

Main Components of Education for Sustainability

Envisioning a better future using futures orientated thinking to establish links between long-term goals and present actions and motivating people to action by harnessing their deep aspirations.
Using *critical thinking and reflection* to challenge people to examine and question the underlying assumptions, knowledge and opinions that shape our world, by looking beneath the symptoms of unsustainable practice; while empowering them with the confidence needed to address the dilemmas and challenges of sustainable development.
Using *participation* in a deeper way than mere consultation, by involving people in joint analysis, planning, and control of local decisions. Additionally, learners should participate in decisions about how they are to learn.
Developing *partnerships for change* to strengthen a sense of ownership of decisions and commitment to sustainability actions through formal and informal opportunities for learning.
Using *systemic thinking* as a better way to understand and manage complex situations, by recognising that the whole is more than the sum of its parts.

ESD is fundamentally about values, with respect at the centre. UNESCO (2004) outlined an expectation that ESD would promote *at least* the following:

- respect for the dignity and human rights of all people throughout the world and a commitment to social and economic justice for all;
- respect for the human rights of future generations and a commitment to intergenerational responsibility;
- respect and care for the greater community of life in all its diversity which involves the protection and restoration of the Earth's ecosystems; and
- respect for cultural diversity and a commitment to build locally and globally a culture of tolerance, non-violence and peace (p. 16).

Nonetheless, UNESCO recognises that education alone is unlikely to instil such values into students; rather that education constitutes "the central pillar" of strategies to promote respect and other values as "alongside positive spiritual motivations, education is our best chance of promoting and rooting the values and behaviours which sustainable development implies" (p. 16).

Science teachers have a crucial role to play in preparing students to be able to make critically informed judgments when exposed to expert discussions about the environment, and to be able to engage in the debate with confidence and skill. One of the *Melbourne Declaration on Educational Goals for Young Australians* (2008) is that all young Australians become "active and informed citizens [who] work for the common good, in particular sustaining and improving natural and social environments" (p. 7). Cutter (2001) has outlined the important role EE has to play at primary, secondary and tertiary levels in the development of students who are "capable of understanding and who are motivated to respond to the issues which give rise to an environmental crisis" (p. 4). Despite this, the education sector in Australia seems to have been resistant to move towards implementing the ideas of ESD/EfS and there are few aspects of current curricula that have a focus on learning for sustainable development.

This emerging area of science education is regarded by no less than the United Nations as 'critical', but little research has been done to determine how effectively this aspect of the school curriculum is taught. Research into the understanding of science among lay citizens has consistently revealed a widespread lack of understanding of fundamental science concepts. In addition, there is little research in the area of ESD to suggest which aspects of the learning environment are most effective in supporting the environmental literacy of students. This thesis aims to address these issues, by measuring environmental literacy, i.e., the knowledge, values, awareness and actions of students towards environmental and sustainability issues.

2.3 Environmental Education Policy and Implementation in Australian Curricula

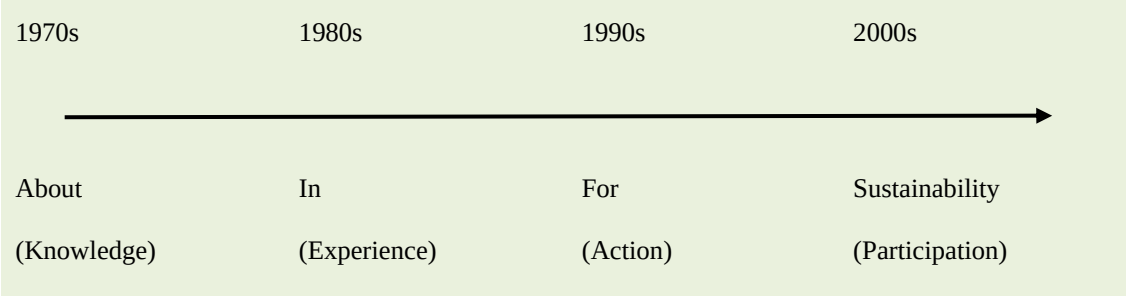
2.3.1 Evolution of Policy Approaches to Environmental Education

> Education has been increasingly recognised as an important means to achieve sustainability. For years it was considered the soft option, often conducted by people who were not educators. Now education has finally come into its own. Indeed, other environmental management tools – policy, legislation, regulation, incentives and infrastructure development (considered by some as the *real* stuff!) are using/integrating education approaches to carry forward their impact. There's more talk of engaging the community, inspiring and motivating, informing and building commitment and strengthening action capacities within these other approaches. Perhaps the world is catching up with education.
>
> Collier and Smith (2007, p. 5)

In the 1970s, the focus of EE was educating *about* the environment. By the early 1980s, the focus had shifted to experiencing environments and education *in* the environment. By the mid-1908s the focus had again shifted and action-oriented objectives began to feature in EE plans and programs. The term 'education *for* the environment' was associated with this shift. By the late 1990s and into the 2000s the focus shifted again, this time to the sustainability agenda, with moves away from single actions such as

planting of trees and recycling paper, towards a focus on student participation in decision-making. Such an approach to sustainability is important for embedding change, although James (2006) has pointed out that statements related to EE and EfS/ESD still generally come from environment agencies rather than education departments, reinforcing the political priority over the educational priority, and Gough (2011) has examined the "ongoing tensions between science education and environmental education in Australia's formal school curriculum" (p. 1).

Figure 2.1 shows this evolution in policy approaches to EE. There is a lag of about a decade before shifts in EE approaches called for by the literature become embedded in environment and education policies. This time lag is likely to continue in the future.



Adapted from Tilbury, D., Coleman, V., & Garlick, D. (2005, p. 26).

Figure 2.1 Evolution of policy approaches in environmental education

2.3.2 Implementation of Policy Approaches to Environmental Education

> We have not yet engaged quickly or thoroughly enough with the challenges of global warming, biodiversity depletion, water shortages, emission reduction and other environmental issues. It's seemed at times that the national head has been not so much in the sand as in the pocket: policy and politics have urged and encouraged us to keep working, get comfortable, have it all, don't think and don't worry.
>
> Collier & Smith (2007, p. 3)

The commitment by governments to an EfS approach requires a re-examination of educational policy, with a view to the re-orientation of education from pre-school through to university and continuing adult learning, in order to focus clearly on the development of the knowledge, skills, perspectives and values related to sustainability. This implies that existing curricula will need to be reviewed in terms of their existing objectives and content, and overhauled to incorporate developing understandings of how sustainability covers the social, economic, environmental and cultural and runs across all disciplines.

The recommended and mandated approaches to teaching, learning and assessment also need to be reviewed, so that lifelong learning skills such as creative and critical thinking; oral and written communication; collaboration and cooperation; conflict management; decision-making, problem-solving and planning; and practical citizenship are fostered. Furthermore, education systems will need re-shaping so that this emerging kind of learning is validated through assessment processes. In addition, teacher education will need to prepare teachers for active/interactive learning processes, rather than one-way transfers of knowledge. Finally, governments must ensure that such educational approaches are available to the whole population. UNESCO (2004) cautions that education systems, such as that found in Australia, which maintain parallel private systems available to the wealthier sections of the population, may not convey the values of equity, dignity and respect which underpin sustainable development, particularly where the public system is held to be inferior.

Although it is unrealistic to think that education alone can drive and implement the entire sustainability agenda education seems, by default, to have become the main driver rather than one of many tools of public policy. Collier and Smith (2007) have pointed out that while most jurisdictions in Australia have had only vague policies about sustainability to act as a framework in which to place EfS they do have approaches to education that have allowed EfS to be placed it firmly within them.

Thus the 2002 National Action Plan *Environmental Education for a Sustainable Future*, first linked EE and sustainability; and in NSW the Government's *Learning for*

Sustainability: NSW Environmental Education Plan 2002 -2005 took this a step further. The Federal, State and Territory and international approaches to EE are now examined in turn, along with the development of the National Curriculum.

At the Federal level

Many texts explain the 'what' and the 'why' of ESD but few attempt to capture the intricacies of 'how' to bring it into practice. Recently there have been attempts to plan a national approach to EE and ESD. Direction at the national level was initially provided by the 1999 *National Goals for Schooling in the Twenty First Century* (*The Adelaide Declaration*), which outlined a set of common goals endorsed by all State and Territory Education Ministers for use in school education. Goal 1.7 stated that when students leave school they should "have an understanding of, and concern for, stewardship of the natural environment, and the knowledge and skills to contribute to ecologically sustainable development" (Ministerial Council on Education, Employment, Training and Youth Affairs, 1999).

The report *Today Shapes Tomorrow: Environmental Education for a Sustainable Future*, was issued by the Federal Minister for the Environment and Heritage in January 1999 as a result of a community consultative process which generated a large number of proposals for future actions. These included the development of a national framework for EE activities; raising the profile of EE in Australia; better coordination of EE activities; greater access to quality materials; more professional development opportunities for teachers in the formal education sector; more integration of EE principles into mainstream education (including tertiary level education) and vocational training activities; and better resourcing of community organisations involved in EE.

In 2000, the Department of the Environment and Heritage released the Government's *Environmental Education for a Sustainable Future: National Action Plan*. The Plan was intended to provide a framework and direction for EE activities in Australia, recognising its role in contributing to change towards sustainability. Though the Plan did not purport to meet all needs, nor replace the activities of the many government and non-

government organisations currently engaged in educating the community about environmental issues, it promoted the importance of cross-sectoral and multi-stakeholder partnerships as well as recommending the establishment of a *National Environmental Education Council* (NEEC). The Council's membership, from a variety of sectors, was to provide advice and recommendations to the government on EE matters. The *National Action Plan* outlined several other mechanisms to be established by the Federal Government by which Environment Australia would work in partnership with formal education authorities to achieve the goals of the plan including the *National Environmental Education Network* (NEEN), and the *Australian Research Institute in Education for Sustainability* (ARIES).

A key element in the Na*tional Action Plan* was a move from an emphasis on raising awareness to providing people with the knowledge, values and skills to allow them to actually make a difference to the protection and conservation of Australia's environment. The Plan also called for greater integration of EE and sustainability principles into mainstream education, not only with in formal school settings, but in a wide range of non-formal education settings, as well as more professional development opportunities for teachers.

The plan outlined five principals of EE that would promote a sustainable future and develop a community committed to ecologically sustainable development:

- EE must involve everyone and cannot be confined to any one group in society. It is the responsibility of governments, industry, the media, educational institutions, and community groups; as well as individuals.
- EE must be life-long as information about environmental issues is always improving. As knowledge is acquired from past experiences and mistakes and as improved environmental technologies are developed and applied the ability of society and individuals to respond effectively also improves.
- In order to address environmental challenges EE must be holistic and people need to think broadly to understand systems, connections, patterns and causes.

- EE must be practical and lead to actions which result in better environmental outcomes, rather than simply the accumulation of inert knowledge or impractical skills.
- EE must be in harmony with social and economic goals and accorded equal priority. Effective EE must encourage the pursuit of environmental goals in a way that acknowledges other powerful and legitimate social and economic goals and should not be taught in a vacuum, or simply equip people to pursue an agenda on the margins of society.

The Australian Government moved quickly to implement many of the initiatives contained in the *National Action Plan*, with mixed outcomes. The NEEC was established in July 2000, and was comprised of experts in EE from different sectors as well as eminent community leaders. Its purpose was to promote a coordinated national approach to move Australians beyond environmental awareness to informed action. This was to be achieved by maintaining an overview of Australia's EE programs with a view to identifying priority EE issues and research needs, providing expert advice to the Minister for the Environment and Heritage on EE issues, and working to by raising the profile of environmental issues in all sectors of the community. In 2001, the NEEC commissioned a review, undertaken by the Curriculum Corporation, of nationwide curriculum documents to comprehensively map how EE was represented and to identify national priorities. The results of this review are discussed in the next section. The NEEC seems to have last met on July 2007, and was subsequently renamed the *National Council on Education for Sustainability* in 2009, with one meeting being held in April.

The National Environmental Education Network (NEEN) was established in May 2001. It was comprised of representatives from Commonwealth, State and Territory environment and education agencies. Its purpose was to promote better coordination of education activities. The NEEN is now known as the *National Education for Sustainability Network*, aims to improve inter-governmental coordination of the delivery of EE, by promoting more efficient use of resources and better outcomes between Commonwealth, State and Territory environment and education agencies.

An independent *Australian Environmental Education Foundation* (AEEF) was also to be established by the Commonwealth Government in an Australian university. The role of the Foundation was to advance scientific knowledge and capability in relation to the Australian environment to ensure that knowledge and understanding informed the decisions of communities, corporations and governments. The charter of the AEEF was to include the provision of professional development and a program of EE Fellowships for teachers in the formal education sector and others involved in EE. In 2003, the AEEF was renamed the *Australian Research Institute in Education for Sustainability* (ARIES) and was established at Macquarie University where an applied environmental education research program is underway. ARIES continues to use action research and collaborative programs with all sectors of society to inform, promote and support change for sustainability.

Environment Australia (a private company based in Queensland) was to promote the importance of EE in ensuring that Australia has a sustainable future. It was to communicate with the popular media (given its impact on community attitudes), specific sectors such as business and industry, and other Commonwealth agencies; as well as upgrading its existing EE web site to provide greater access to a range of EE material. Environment Australia has published several significant reports, including *Today Shapes Tomorrow: Environmental Education for a Sustainable Future, A discussion paper* (1999) and *Environmental Education for a Sustainable Future: National Action Plan* (2000).

Now known as Environment Training Australia; the website currently reports that its primary objectives are to provide environmental education and industry specific training (such as Certificate IV Business Sustainability Assessment**)**. The other objectives do not appear to feature prominently.

Although the incorporation of ESD into curricula at this stage seemed to have stalled, a pilot Sustainable Schools program was implemented in Victoria and New South Wales in 2002 and 2003, followed by the establishment of the national *Australian Sustainable Schools Initiative* (AuSSI) in 2004. AuSSI, a partnership of the Australian Government

and the States and Territories, has prospered and Gough (2011) has called it "one of the longest lasting and most impressive actions from the first National Action Plan" (p. 5). Thirty percent of schools across Australia are now participating in AuSSI as it seeks to support schools and their communities to become sustainable. This program aims to provide ways for students, teachers, parents and the wider community to be actively involved in sustainable school management. The initiative fosters a whole school approach with practical support leading to measurable environmental, educational, social and financial benefits. AuSSI is discussed in more detail in Section 3.3.3.

In 2005, the Department of the Environment and Heritage published the second national statement on EE: *Educating for a Sustainable Future – A National Environmental Education Statement for Australian Schools.* All Australian and State and Territory Ministers for Education endorsed the Statement at the meeting of the *Ministerial Council on Employment, Education, Training and Youth Affairs* (MCEETYA) in May 2004, coinciding with the first year of the United Nations DESD (2005-2014). It was intended as a companion to existing State and Territory policies and programs and to be used by teachers, schools and their communities, education systems and developers of curriculum materials, and attempted to move EE from being a discrete subject in the conventional curriculum to a new orientation of the curriculum. The problem with the document was that, as it required the agreement of all States and Territories, and in the absence of a national curriculum, its wording was cautious to allow for liberal interpretations across jurisdictions.

This document was developed collaboratively with significant input from government and non-government organisations and provided a nationally agreed description of the nature and purpose of EE/EfS through all years of schooling, including a vision and a framework for its implementation. Notably, it suggested a 'whole school approach' for EE, consistent with that of the Australian Sustainable Schools Initiative (AuSSI), which sees a curriculum-only focus as inadequate. Bolstad, Baker, Barker, and Keown (2004) concur that "whole-school approaches are advocated as best supporting the implementation of Environmental Education in a way that reflects the goals, aims, and

purposes of this area… Whole school approaches also appear to be most successful when they build on the existing culture, priorities, and values of schools and their communities" (p. 95).

In 2008, the State and Territory Education Ministers signed the *National Declaration on the Education Goals for Young Australians* (*The Melbourne Declaration*, 2008). Although the document was an update of the *Adelaide Declaration*, it no longer explicitly mentioned environment and sustainability issues, apart from a small paragraph on page 5 stating

> complex environmental, social and economic pressures such as climate change that extend beyond national borders pose unprecedented challenges, requiring countries to work together in new ways. To meet these challenges, Australians must be able to engage with scientific concepts and principles and approach problem-solving in new and creative ways" and vague statements pledging that students will "work for the common good, in particular sustaining and improving natural and social environments", be "responsible global and local citizens (p. 9).

The Melbourne Declaration did recognise the importance of learning through partnerships in schools and committed to "developing stronger partnerships" (p. 10), but failed to define the purpose and type of partnerships (so important to both environmental and educational sectors) envisaged.

Documents such as *Sustainability Curriculum Framework: A guide for curriculum developers and policy makers* (DEWHA, 2010) defined EfS as helping students to "learn to design and implement actions that can contribute to a more sustainable future." (p. 3). The impetus of this document was the development of the first National Curriculum, which includes sustainability as a cross-curriculum focus.

The *Sustainability Curriculum Framework* provided a scaffold structured into three broad year groupings (K-2, 3-6 and 7-10) that described what students may need to learn in order to live sustainably, and considered the most appropriate times and environments

in which learning should occur. In each of the three broad year groupings, the content was presented under the three organising themes, the Sustainability Action Process, Knowledge of Ecological and Human Systems and Repertoires of Practice. This then allowed curriculum developers and policy makers to align the framework's content across learning areas and enable EfS to be effectively incorporated into the curriculum through in-depth focused teaching in particular years, although this document did not specify *how* EfS should be taught across the curriculum. Unfortunately there is little evidence of it having been used in the development of the new National Curriculum; however it remains a useful reference document for teacher educators and others.

Although the updated *National Action Plan* (2000) acknowledged that "changes in popular perspectives, values, knowledge and skills to achieve changed behaviour in support of a sustainable environment will not occur overnight" (p. 5) the intervening fourteen years seem to have seen very little happen in terms of implementing EE into Australian schools and universities and there continues to be a tension between how to implement the worthy aspirations of international policy agreements around ESD/EfS in Australian curricula. *The Melbourne Declaration on Educational Goals for Young Australians* (MCEETYA, 2008, p. 14) called for the incorporation of sustainability across the curriculum, the *Sustainability Curriculum Framework* (DEWHA, 2010) attempted to put sustainability education into a cross-disciplinary curriculum for Years K-10; yet at the same time as the National Curriculum proposed *Earth and Environmental Science* as a separate subject at Year 11 and 12 levels (National Curriculum Board, 2009a).

The Plan stated that EE needs to "influence mainstream society in a way which progresses environmental objectives along with other legitimate social and economic objectives" (p. 4), however some educators strongly resist the idea of using education as an instrument of policy and of adding yet more to an already overcrowded curriculum. It is therefore not surprising to observe that progress towards EE/EfS in this sector is slow with many efforts resulting only in the integration of some sustainability concepts into curriculum content, rather than in educational change. The goals of the *National*

Action Plan cannot be achieved solely through tweaking the curriculum to integrate some sustainability content. It requires a fundamental shift in current practice and a different pedagogical view.

At the State and Territory level

Despite the national goals outlined in the previous section, the decentralised approached employed in Australia means that it is the States and Territories who formulate their own education policies. Until there is a fully implemented national curriculum, there can be no centralised, national ESD policy, although the States, Territories and local government have also resourced a number of EE/EfS programs and often have significant policy and planning in place.

As mentioned, in 2001 the NEEC commissioned a nationwide review of curriculum documents, in order to identify where EE was represented within curriculum outcomes from K-12. The indicators developed for the review were based on the objectives identified in the 1977 Tbilisi Declaration and were:

- information about the environment;
- studies of humans and the environment;
- skills used to investigate the environment;
- positive attitudes towards the environment;
- investigating and clarifying environmental viewpoints;
- environmental problem solving; and
- taking environmental action.

The *Curriculum Corporation* (2003) undertook the review and found there was wide variation in the nature and extent of references to EE across the States and Territories. Initially focused on aspects of environmental science and conservation in Science and Geography subjects, with the exception of NSW, EE has never been a mandatory component for Australian schools. As would be expected, EE learning outcomes were found predominately in the Key Learning Areas (KLAs) of Science and Studies of

Society and the Environment (SOSE), although some references occurred in Health and Physical Education, Technology and Mathematics. Each discipline tended to emphasise those aspects of EE that interlinked most strongly with the conceptual understandings pertaining to that area. The Key Competencies are an important feature in many of the State and Territory curriculum documents and provided windows of opportunity for including EE in disciplines such as English and the Arts, while the general nature of some learning outcomes could also provide teachers who are minded to do so with opportunities to deal with environmental and sustainability issues in any KLA.

EE policy has been focussed on integration across the eight KLAs, which provide the basis of the compulsory curriculum from ages 5 to 15 in Australia; however the highly structured KLA framework allocates particular content to specific learning areas and discourages integration of ideas across learning areas. This makes it difficult to promote a holistic integrated approach to EE and does not provide opportunities for students to make connections from a broader perspective between bodies of knowledge. The review found that most State and Territory documents placed EE as a cross-curricular perspective in schools; promoting it as a strand within KLAs, Essential Learnings and/or Learning Area Objectives. In Queensland, ACT and NT, there were specific curriculum guidelines for EE. In WA, SA, and Tasmania, EE was integrated into the core curriculum documents. Only NSW, Queensland and Victoria have EE policy documents, but NSW is still the only state where EE is mandatory in government schools and where there is a 'whole-school approach' to EE and sustainability.

Across all States and Territories, there were fewer opportunities for EE at the senior secondary level than during the compulsory years of schooling. Within this framework, senior students encounter EE only as a cross-curricular perspective that *might* be incorporated into all KLAs but which, in reality, competes with other cross-curricular strands.

In the Science KLA, all of the State and Territory documents contained learning outcomes based around learning *about* the environment, especially in the content areas of ecology, energy and resources. The limited opportunities for education *for* the

environment and for facilitating action or exploring mechanisms for social change were highlighted by the review.

A wide range of skills and competencies were found in each of the curriculum documents, and the curriculum review identified the potential for EE skill development in Science, SOSE and Arts curricula across all States and Territories. Learning skills such as *participation, futures-thinking, critical thinking* and *reflection* have been identified by EE thinkers as central to helping people and societies move towards sustainability. However, in many KLAs the focus remains on collecting, organising, analysing and communicating information and ideas, albeit often in a very sophisticated way. The review noted that SOSE and the Arts embraced a process-based approach, which promoted the development of reflective and critical thinking skills in their students; however it is not clear from the curriculum audit whether specific opportunities were offered where these skills can be developed.

The values and ethics dimension of EE was not a strong feature in most documents. Social justice issues, particularly those relating to poverty and the developing world, or our responsibility to future generations, were not well represented. Only in science were opportunities offered to students to allow them to develop an appreciation of the interrelationship between science, technology, society and ethics, however this development of values and attitudes was found to focus on developing ideas such as environmental stewardship, rather than values clarification. Values clarification can be defined as the uncovering of the beliefs and assumptions that underpin an individual's actions. The power to effect attitudinal, and therefore behavioural, change is a crucial aspect of EE, but learning outcomes dealing with personal actions were rare.

A curriculum focus on *action* was found in only found in a small number of cases. The New South Wales and Queensland EE documents promoted environmental citizenship action through the SOSE KLA. In Queensland and South Australia the curriculum guidelines for senior level Geography and in Victoria for Environmental Studies, action competence was promoted as a learning outcome. However, these courses were not part of the curriculum at compulsory levels of schooling. Learning outcomes that addressed

action and action competencies associated with education *for* the environment were not found in the Science KLA, except for South Australia which addressed actions such as energy conservation and waste minimisation in their Science syllabuses.

In the senior years, EE was a major feature in most Geography subjects, Outdoor Education courses and some science subjects, such as Environmental Studies. Outside these specialist subjects there seemed to be fewer opportunities for EE than in the compulsory years of schooling. Even students who chose rigorous senior science subjects such as Biology, Chemistry and Earth and Environmental Science followed a course of study that tended to focus on student learning *about* the environment. The curriculum documents accompanying such courses were found to vary in their nature and quality, meaning that the usefulness of the way EE principles were explained and demonstrated to teachers varied. This, in turn, may diminish the way they influenced teaching and learning if they were not perceived as relevant and easy to apply to current classroom practice.

The report also noted that concepts commonly associated with EE such as eco-efficiency, lifecycle analysis, natural resource accounting, carrying capacity, precautionary principle and ecological footprints were underrepresented in Australian curricula. Specific environmental issues, such as global warming and endangered species were rarely mentioned in student learning outcomes, and while 'sustainability' was a term commonly found within the SOSE, Environmental Science and most Geography curricula but was not used consistently. Sometimes it referred to resources, while at other times it referred to consumption patterns or human settlement. Few KLAs outside of Science referred to sustainability. Only the Western Australia SOSE curriculum and South Australian Science curriculum were found to feature sustainability and its issues strongly. Biodiversity was featured in most Science and Biology curriculum documents, but was not a major theme, and appeared in only a few KLAs.

In contrast, the Curriculum Corporation (2003) found that there was a lot of detailed information about sustainability issues in textbooks and that EE topics were major features. This was considered to be a reflection on the different roles played by

textbooks and curriculum documents in the development of teaching programs in schools.

The Curriculum Corporation gave some recommendations that could be acted upon immediately, including:

- promoting examples of whole school programs and subject specific programs that incorporated and built upon existing learning outcomes to incorporate EE into learning;
- providing examples where environmental issues could be considered within the more general learning outcomes of existing curriculum documents;
- introducing aspects of EE that were presently overlooked or poorly treated, but which could easily be treated with greater emphasis; and
- establishing a nationally accepted set of criteria for the evaluation of effective EE resources and programs to assist teachers in their development of EE programs.

The report also appealed for EE activities in schools to be holistic and school-wide in nature, incorporating themes such as biodiversity, sustainability, values and viewpoints, as "whole school initiatives have proved to be more successful in shaping student skills, values, actions and have measurable outcomes" (p. 5), while also involving personal actions.

Despite moves in recent years where the States, Territories and local governments have often developed significant policy and planning and have also resourced a significant number of EE and EfS programs, this approach has meant, in practice, teachers (with the exception of those in NSW) do not have to consider EE as a component of their work. As a result, although there are many curriculum opportunities for EE, whole-school approaches are rare and there has been little in the way of systematic efforts to place EE into the curriculum and give it a meaningful presence (Gough, 1997). EE seems to be only the concern of dedicated enthusiasts within schools rather than a concept supported by whole school communities and thus sustainability continues to be a peripheral, rather than central focus.

The review concluded by recommending a National Environmental Education policy be developed to guide teaching and learning from K-12. The development of such a policy would have needed to have the support of all State and territory jurisdictions, all relevant professional teacher organisations and all EE stakeholders. Given the ongoing difficulties in delivering a National Curriculum, it is not surprising to realise that this worthy goal has not been achieved, although in 2010 the Federal Government released the *Sustainability Curriculum Framework*, as discussed in Section 2.2.2.

New South Wales

The NSW Department of Education and Training's *Environmental education policy for schools* (2001) states that when EE is incorporated into the school curriculum, students "learn *about* the environment, develop skills to investigate and solve issues *in* the environment, acquire attitudes of care and concern *for* the environment, adopt behaviours and practices which *protect* the environment, and understand the principles of ecologically sustainable development." (p. 9) and defines EE as "a lifelong multi-disciplinary approach to learning that helps people to understand and appreciate the environment and their connection to and impact on it" (p. 6).

In 2002, the NSW Council for Environmental Education developed an EE plan, *Learning for Sustainability: NSW Environmental Education Plan 2002 -2005,* for the NSW Government. As part of the process, the NSW syllabuses were reviewed and concerns about the EE content within some of them outlined. One concern was the underlying inference that the environment is separate and apart from people and society. The title of the KLA 'Human Society and its Environment' reinforces this dichotomy, yet EE is cross-curricula and goes beyond discrete courses of Science, Geography, Design and Technology or other studies of society and environments.

The review also found there is an emphasis on raising awareness *about* the environment without stressing a need to take action *for* the environment. The concept of sustainability was not overtly defined.

In 2004, Smith also reviewed the NSW syllabuses in order to identify the limitations of EE and learning for sustainability within the current curriculum. He called for a separate course on *Learning for Sustainability* in Years 7-12:

> Courses should contain themes such as intergenerational equity, social justice, ecological sustainability, cultural diversity, intercultural understanding, the fair distribution of wealth and resources, democracy and peace. The outcomes should relate to an understanding of power, the value of participation and ownership and the achievement of skills in capacity building, 'critical' thinking, futures thinking, integrated thinking and action and the exploration of the change process. The course should be holistic, integrated, supportive of the value of working towards a more sustainable lifestyle and future. (p. 7)

This certainly does not sound like any course in any current Australian syllabus! Fien (2001a) put forward a similar case for the introduction of a core program of studies in sustainability in Years 11 and 12. He recommended the need for pedagogical thinking and practice based upon inter-disciplinary curricula; one that has a problem-solving focus and outcomes orientated teaching strategies. Fien envisaged both a new inter-disciplinary subject on sustainable futures and the integration of the principles and practices of sustainability into all relevant subjects and teaching strategies. He felt this would ensure teaching and learning experiences that would encourage students to "explore questions, issues and problems of sustainability in contexts relevant to them and their communities, from local to global" (Fien, 2001a, p. 2).

Coad (2003) has also argued that LfS is a curriculum imperative, although she acknowledges that it would require a significant shift in current curriculum practice. She accepts Sterling's (2001) argument that that LfS is not solely about integrating new content into the curriculum or simply tacking on a cross-curricula theme. Rather it is about challenging teaching and learning approaches and, as such, implies uncomfortable tensions may arise as EE moves away from being a subset in Science and Geography syllabuses towards becoming a truly cross-curricular underpinning within schools.

Nonetheless, progress has been made. The NSW Government's Environmental Education Plan *Learning for Sustainability* (2002) set out ways to build knowledge of LfS and assist the people of NSW to move towards a more sustainable society, while the *Our Environment – It's a Living Thing Professional Development Program* was offered in 2002 to assist educators to develop community education programs or adapt existing programs to address issues of sustainability (Tilbury, Garlick & Henderson, 2004). The *Environmental Education Plan* was updated in 2006.

The *Living Change: Documenting good practice in Education for Sustainability in NSW.* report (2006), developed by Macquarie University and the Nature Conservation Council, NSW was an attempt to capture the experiences of educators making changes to their programs. Two case studies were included, *Cool Communities*, nationwide partnership program focused on making changes in households towards greenhouse gas abatement, and *Sustainable Schools*, which invited both government and non-government schools to participate in incorporating the sustainability agenda into the school and broader community.

Internationally

International research confirms that the slow pace of moves from EE to ESD/LfS is not unique to Australia. A study authored by Rickinson (2001) for the National Foundation for Educational Research in the United Kingdom not only confirmed the tendency to locate EE within Geography and Science subjects, but also that scientific teaching *about* the environment could be disempowering.

The Rickinson study undertook a review of over 100 international journal articles, books and reports dating between 1993 and 1999 relating to EE in schools. The review aimed to chart the nature of current evidence on learners and learning in EE, identify key messages emerging from this evidence and assess the limitations of these in terms of empirical underpinnings. It also sought to raise questions about the nature, quality and accessibility of recent EE research and suggested priorities for future work.

Rickinson found that the environmental knowledge of students was generally low, although science based, and that students had a limited understanding of the complexities of environmental issues. The views of students collated in this study revealed a range of concerns and much pessimism. Environmental attitudes and behaviours were found to be influenced by gender and socio-economic factors, and overtly scientific teachings about the environment where found to be disempowering.

The review did find that certain aspects of EE programs appear to bring about positive outcomes and change learners' environmental knowledge, attitudes and actions, however little appears to be known about how or why such programs are able to bring about certain kinds of learning outcomes. All teachers are aware that students experience learning situations in active and individual ways (which may even conflict with their teachers' experiences). The review suggested that students' attitudes may even change sufficiently for them to then influence the behaviour of parents, but that this does not happen automatically.

Rickinson found that little evidence has been garnered by the research to suggest which factors most influence students' perceptions of nature, although action oriented programs appear to have more success than specific content issue programs. The findings led Rickinson to conclude that there have been many more studies focussed on investigating the characteristics of school students than there have been exploring the process or outcomes of environmental learning. He suggests these were areas worthy of further investigation.

2.3.3 The National Curriculum

The independent body, the *Australian Curriculum Assessment and Reporting Authority* (ACARA) is currently developing the National Curriculum. This body has the main educational responsibility for the introduction of environmental/sustainability education in Australia. This new curriculum will eventually cover Foundation to Year 12 in all States and Territories, and the implementation began in 2014.

ACARA is structuring the National Curriculum through three key cross-curriculum priorities; *Sustainability*, *Aboriginal and Torres Strait Islanders histories and cultures* and *Asia and Australia's engagement with Asia*, which are to be embedded in all learning areas. Cowan (2011) has outlined how these cross-curriculum priorities "will have a strong but varying presence depending on their relevance to the learning areas" (p. 13).

The *Sustainability* priority is outlined by ACARA as follows:

> Sustainability addresses the ongoing capacity of Earth to maintain all life.
>
> Sustainable patterns of living meet the needs of the present without compromising the ability of future generations to meet their needs. Actions to improve sustainability are both individual and collective endeavours shared across local and global communities. They necessitate a renewed and balanced approach to the way humans interact with each other and the environment.
>
> Education for sustainability develops the knowledge, skills, values and world views 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.
>
> (ACARA, 2014, "Sustainability", para. 1-3)

A set of *organising ideas* (OI) is used to outline the essential knowledge, understandings and skills for the *Sustainability* priority. The OI are embedded in the content descriptions and elaborations of each learning area as appropriate. These are outlined in Table 2.3

Table 2.3

ACARA's Organising Ideas for the Sustainability *Priority.*

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.
OI.3 Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.
WORLD VIEW
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.

Disappointingly, in the draft Year 10 Science curriculum, ACARA had moved away from specifically mentioning these ideas.

The statements on the Cross–curriculum Priorities page of the ACARA website states that:

> Science explores a wide range of systems that operate at different time and spatial scales. By investigating the relationships between systems and system components and how systems respond to change, students develop an appreciation for the interconnectedness of Earth's biosphere, geosphere, hydrosphere and atmosphere, Relationships including cycles and cause and effect are explored, and students develop observation and analysis skills to examine these relationships in the world around them.
>
> In this learning area, students appreciate that science provides the basis for decision making in many areas of society and that these decisions can impact on the Earth system. They understand the importance of using science to predict possible effects of human and other activity and to develop management plans or alternative technologies that minimise these effects.
>
> (ACARA, 2014, "Science Cross-curriculum priorities", para. 12-13)

This does not seem to be related to the Organising Ideas and seems to contradict the statement of Palmer (2011) of ACARA, in an article entitled *The Sustainability Priority in the Australian Curriculum* who said that "sustainability has a place in each learning area, but the extent and nature of its representation varies depending on its relevance for the learning area. Science, Geography, Technologies and Civics and Citizenship are regarded as 'heavy lifters'" (p. 9) and that "the Australian Curriculum offers some real opportunities to embed sustainability throughout all the years of schooling" if teachers can be "creative about the way you mix and match the sustainability priority, the other priorities, general capabilities and learning area content" (p. 12).

The ACARA Organising Ideas for the *Sustainability* priority are referred to in the paper that helped guide the writing of the Australian Science curriculum K-12, but the term *contemporary science* is used to refer to many aspects of EE. *Contemporary science* is defined as involving "new and emerging science research and issues of current relevance

such as energy resources and technology, climate change and adaptation, mining and minerals, biodiversity and ecological sustainability, materials science and engineering, health and prevention and treatment of disease" (National Curriculum Board, 2009b, p. 5). The term 'sustainability' is only used in terms of sustainability of systems, to refer to the ideas of inputs, functions and outputs, renewable and non-renewable resources. The sustainability message seems to have been diluted and dissipated.

To further compound the problem, the curriculum statement has the 'Science Understanding' strand broken down along the traditional disciplines of biological sciences, chemical sciences, earth and space sciences and physical sciences. There is a proposal for an 'Earth and Environmental Science' course in Years 11 and 12, which only a small number of students are likely to study (the NSW *Earth and Environmental Science* course had 1473 HSC candidates in 2011). In addition, the subject would seem to be more geology and biology than environmental science, with a closer resemblance to the New South Wales HSC subject *Earth and Environmental Science* (Board of Studies, 2009) than the VCE *Environmental Science* (VCAA, 2012).

The *Australian Association for Environmental Education*'s (AAEE) response to the draft Science curriculum was the most detailed, and recommended "that 'science, citizenship and policy making' be included as content descriptor for all Year levels of the *Science as Human Endeavour* strand and as a key element of scientific inquiry" (Smith, 2010, p. 7). ACARA does not seem to have incorporated these proposals, or the EfS goals of the *National Action Plan* (2009), or the *NSW Environmental Education Plan* (2006).

Teachers are to apply sustainability as a cross-curriculum priority, but may well encounter the same issues they currently have with existing curricula, where a fragmented, piecemeal approach by some teaching programs in some schools occurs. James (2006) argues that "teachers have struggled to implement environmental education under previous, simpler curriculum key learning area based models… so it is debatable that they will be able to implement the more complex ESD perspectives within a more complex three stranded curriculum model without considerable support" (p. 10).

Most disturbingly, Professor Barry McGaw (Canberra Times, 2014) has responded to criticisms about the cross-curriculum priorities in a way that seems to deny their importance. Despite stating that the priorities are embedded where they naturally fit in subject disciplines, they are often contained in elaborations, which are ideas that teachers may or may not choose to use, and there is no requirement that subjects be taught through the cross-curriculum priorities. One might ask what the point of the cross-curriculum priorities is if that is the case.

It appears to be too late to reverse this diminution of the role of ESD in the National Curriculum. Most of the content statements seem to reflect a very similar approach to the existing science curricula. Since 2011, lead schools have participated in a pilot program for the first four subjects, English, Mathematics, Science and History. There have been proposals for the Years 11 and 12 versions of the four key subjects. The areas of Geography, Languages Other Than English and The Arts are currently under development, but there have been no announcements about the inclusion of other subjects in the national curriculum. The pilot program is particularly focussed on the validation of the new Australian Curriculum achievement standards for Foundation to Year 12, but the content statements are unlikely to change. The approach promised in the Science framing paper (National Curriculum Board, 2009a) seems to already be a lost opportunity.

2.3.4 An examination of the NSW Science Syllabuses in Terms of Environmental Education

The NSW Department of Education and Training (2001) defined EE as "a lifelong multi-disciplinary approach to learning that helps people to understand and appreciate the environment and their connection to and impact on it" (p. 6). The *Environmental education policy for schools* also states that when EE is incorporated into the school curriculum, students "learn *about* the environment, develop skills to investigate and solve issues *in* the environment, acquire attitudes of care and concern *for* the environment, adopt behaviours and practices which *protect* the environment, and

understand the principles of ecologically sustainable development." (p. 9). The NSW syllabus refers heavily to values and attitudes, but is very light on actual EE content; although Moyer (1975) has suggested that cognitive understanding does not automatically lead to the development of environmental ethics and behaviours. Which learning outcomes might lead to the sorts of student attitudes and values towards the environment that the policy aims to develop?

The NSW Curriculum is divided into Stages. The Stages under examination in this thesis are Stage 3 (equating to years 5 and 6 of primary school), Stage 4 (years 7 and 8 of secondary school), and Stage 5 (years 9 and 10 of secondary school). In the following analysis, each Stage is examined in turn.

The NSW Science syllabus is called *Science and Technology* (2006) from K-6, while Stages 4 and 5 are called *Science* (2003). While the syllabus for Kindergarten to Year 6 differs from the Year 7 to 10 in how content is organized, there are clear underpinnings of Knowledge and Understanding; Values and Attitudes and Skills from one Stage to another.

A *continuum*, outlined in Table 2.4, is provided in the syllabus to map the transition from Early Stage 1 to Stage 6 in terms of the Knowledge and Understanding, Skills and Values and Attitudes students have developed about each Prescribed Focus Area.

In the K-6 syllabus, 44 outcomes are listed. Fourteen (32%) are directly related to EE and eight (20%) potentially provide further opportunities to include EE. For example, Values and Attitudes outcome VA6 states "Shows informed commitment to improving the quality of society and the environment through science and technology activities" (p. 18).

In Stages 4 and 5, 49 outcomes are listed. Eight (18%) are directly related to EE and twenty-three (46%) potentially provide opportunities for EE, for example, in the Prescribed Focus Area "Implications for Society and the Environment" (p. 11). Though

it is not explicit in the syllabus, there are also outcomes related to current issues, research and development where EE could be incorporated.

Table 2.4

The Continuum of Transition from Stage 3 to Stage 5

	Stage 3	*Stage 4*	*Stage 5*
	A student:	A student:	A student:
PFA Implications for society and the environment	shows informed commitment to improving the quality of society and the environment through science and technological activities	identifies choices made by people with regard to scientific developments	discusses scientific evidence supporting different viewpoints (p. 47)
Knowledge and Understanding Models, theories and laws; Structures and systems	identifies, describes and evaluates the interactions between living things and their effects on the environment	identifies factors affecting survival of organisms in an ecosystem	assesses human impacts on the interaction of biotic and abiotic features of the environment (p.48)
Knowledge and Understanding Interactions	recognises that the Earth is the source of most materials and resources	identifies where resources are found, and describes ways in which they are used by humans	analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources (p. 48)
Skills Students will develop positive values about and attitudes towards the environment	shows informed commitment to improving the quality of society and the environment through science and technology activities	acknowledges their responsibility to conserve, protect and maintain the environment for the future	acknowledges their responsibility to conserve, protect and maintain the environment for the future (p. 51)

Stage 3

The syllabus outlines that students completing Years 5 and 6 are expected to "make decisions involving some conflicting interests or issues, e.g. ethical, aesthetic,

environmental and cultural" and "are aware of a range of issues related to scientific and technological achievements" (p. 55).

In the Domain of *Knowledge and Understanding*, a student in Stage 3:

- identifies, describes and evaluates the interactions between living things and their effects on the environment: and
- recognises that the Earth is the source of most materials and resources

In the Domain of *Values and Attitudes,* a student:

- exhibits curiosity and responsiveness to scientific and technological ideas and evidence
- shows informed commitment to improving the quality of society and the environment through science and technology activities.

The specific content in Stage 3 that relates directly to EE is outlined in Table 2.5.

Stages 4 and 5

The Science Years 7–10 Syllabus (2003), which covers Stages 4 and 5, sits within parameters set by the Board of Studies NSW in its K–10 Curriculum Framework. This framework outlines the education opportunities that K–10 syllabuses and curriculum requirements are designed to provide. The implementation of this syllabus pre-dates Education for Sustainability, and its ideas cannot be easily aligned with any of the six points listed, or with the twelve broad learning outcomes. Many of these do sit comfortably within the strands of adjectival education, and have some relevance to EfS, such as:

> understand and appreciate the physical, biological and technological world and make responsible and informed decisions in relation to their world;

> possess the knowledge and skills necessary to maintain a safe and healthy lifestyle;
>
> understand and appreciate social, cultural, geographical and historical contexts, and participate as active and informed citizens; and
>
> be productive, creative and confident in the use of technology and understand the impact of technology on society (p. 5)

but the environment, sustainability and the challenges of climate change are not mentioned.

The syllabus is arranged as follows:

Rationale → Aim → Objectives → Outcomes → Content (including the contextual setting for Prescribed Focus Areas and Domains).

The *Rationale* outlines how an "understanding of science and its social and cultural contexts provides a basis for future choices and ethical decisions about local and global applications and implications of science" and that the study of science will promote "their development of informed attitudes towards science and the environment" so that "in a scientifically literate way" students will be able to make "decisions about the environment, the natural and technological world." (p. 9)

Table 2.5

The Specific Content Related to Environmental Education in Stage 3 of the NSW Science and Technology Syllabus

Built Environments S3.1

Creates and evaluates built environments demonstrating consideration of sustainability and aesthetic, cultural, safety and functional issues.

- creates a model city using simulation software considering funds, energy sources and services etc.
- selects and uses primary and secondary sources to find information about changes to the local environment over time, e.g. photos and reference material. (p. 21)

Living Things S3.3

Identifies, describes and evaluates the interactions between living things and their effects on the environment.

- devises a presentation for younger students on the likely impact of removing one form of life from a food chain
- plans and manages the construction of a bush food/vegetable garden, identifying and resolving the need for funds and expert advice
- develops a detailed plan to conserve or improve a local nature reserve/park using a simple scale, symbols and annotations
- uses a water testing device to check the water pollution level in a local waterway and discusses findings, e.g. with an expert (p. 25)

Products and Services S3.5

Creates and evaluates products and services, demonstrating consideration of sustainability, aesthetic, cultural, safety and functional issues.

- works collaboratively to evaluate the process used to design and construct a bush food/vegetable garden
- designs a system to mass produce recycled paper products and evaluates the system to make it more efficient
- uses several methods to produce recycled paper and compares the quality of the end products
- collects and records information and identifies some of the pros and cons of mining on Aboriginal lands, e.g. Kakadu, Jabiluka (p. 29)

Physical Phenomena S3.4

Identifies and applies processes involved in manipulating, using and changing the form of energy.

- develops a plan to a simple scale using measurements and constructs a working model to demonstrate the use of a renewable energy source (sun, wind)
- researches and chooses alternative forms of energy to power an energy efficient device or building, e.g. a cooker, a model holiday cabin
- develops and evaluates a variety of ideas for a windpowered vehicle and selects a design which will be constructed as a prototype. (p. 27)

Earth and its Surroundings S3.6

Recognises that the Earth is the source of most materials and resources, and describes phenomena and processes, both natural and human, that form and change the Earth.

- researches information on the causes and effects of catastrophic events such as earthquakes and cyclones
- devises an experiment to simulate the effects of significant weather changes on flora and vegetation, e.g. extreme cold, and reports on conclusions
- plans and constructs a model and evaluates a system designed to overcome wind or water erosion (p. 31).

There are three points within the *Aim* of the syllabus, only one of which mentions the environment, where it is stated that students will "develop positive values about and attitudes towards themselves, others, lifelong learning, science and the environment" (p. 12).

The *Objectives* of the syllabus are divided into three sections, *Knowledge and Understanding, Skills and Values and Attitudes* and are summarised in Table 2.6.

In the *Outcomes* of the syllabus there are five *Prescribed Focus Areas.* One objective relates directly to EfS; "Students will develop knowledge and understanding of implications of science for society and the environment" (p. 13).

Stage 4 – Specific Content

The Stage Statements laid out in Section 9.2 of the syllabus include references to science continuing "to be a changing body of knowledge influenced by new discoveries and

different lines of research which are, in turn, influenced by societal, ethical and religious pressures" and students linking "experiences in the science classroom to developments in current scientific research and describe how these developments will affect their futures". Students are expected to complete this Stage being able to "describe phenomena in the world around them illustrating their descriptions with everyday examples" and "the different factors that make up our environment on Earth, their functions and interactions" and "the usefulness of these as resources for society and the beneficial and detrimental effects of their use" (p. 56).

None of the detailed Stage 4 Outcomes relate directly to the environment or sustainability, or address eco-literacy. In the domain of *Knowledge and Understanding* there are seven outcomes, two of which relate specifically to ecosystems and natural resources:

> 4.10 identifies factors affecting survival of organisms in an ecosystem
>
> 4.11 identifies where resources are found, and describes ways in which they are used by humans (p. 13).

These outcomes are more explicitly detailed in the *Essential Content,* outlined in Table 2.7.

The syllabus also has additional content, however there is no requirement for this content to be taught, and these dot points are not numbered in the syllabus like those above them. These are:

> Atmosphere: discuss some methods used to obtain information about changes in the atmosphere (p. 37); and
>
> Ecosystems: identify factors that affect the size of populations of organisms, including: competition for resources; predators; birth and death rates (p. 39).

Table 2.6

The Objectives of the NSW Science Syllabus Relating to Environmental Education

Objective	*Syllabus reference*
Knowledge and Understanding	"Students will develop knowledge and understanding of implications of science for society and the environment" (p. 12). The specific content in Knowledge and Understanding will be outlined below.
Skills	No reference to the environment is made.
Values and Attitudes	"Students will develop positive values and attitudes towards themselves, others, learning as a lifelong process, science and the environment" (p. 12). "4/5.26 recognises the role of science in providing information about issues being considered and in increasing understanding of the world around them" (p. 16). "4/5.27 acknowledges their responsibility to conserve, protect and maintain the environment for the future" (p. 16). "These include a responsible regard for both the living and non-living components of the environment, ethical behaviour and a desire for critical evaluation of the consequences of the applications of science" (p. 24). "As well as knowing something about science, students need to value and appreciate science and its achievements if they are to become scientifically literate persons and develop positive values about, and positive attitudes towards themselves, others, lifelong learning, science and the environment" (p. 24).

Stage 5 – Specific Content

The Stage Statements laid out in Section 9.2 of the syllabus include references to students discussing "the impact of scientific discoveries and new technologies on everyday life and future society" and having an "informed view when making decisions on the use of new technologies and discoveries and when assessing the scientific claims of others" and "identify, describe and analyse the impacts of the use of resources and discuss the need for and methods of ensuring the conservation, protection and maintenance of the Earth's resources". Students are also encouraged to develop informed values and critical attitudes, including "a responsible regard for both the living

and non-living components of the environment, ethical behaviour and a desire for critical evaluation of the consequences of the applications of science". Furthermore, as well as knowing something about science, "students need to value and appreciate science and its achievements if they are to become scientifically literate persons and develop positive values about, and positive attitudes towards themselves, others, lifelong learning, science and the environment" (p. 57).

Table 2.7

The Specific Content Related to Environmental Education in Stage 4 of the NSW Science Syllabus

Outcome 4.9 A student describes the dynamic structure of Earth and its relationship to other parts of our solar system and the universe.
4.9.4a) the atmosphere A student learns to identify gases that comprise the greater percentage of air and explain the difference between Earth's atmosphere and space. **4.9.4b) the atmosphere** A student learns to describe the importance of atmospheric gases, including ozone and greenhouse gases, to life on Earth. **4.9.5c) the hydrosphere** A student learns to describe the water cycle in terms of the physical processes involved (p. 37).
Outcome 4.10 A student identifies factors affecting survival of organisms in an ecosystem.
4.10a) ecosystems Students learn to describe some adaptations of living things to factors in their environment. **4.10b) ecosystems** Students learn to describe, using examples of food chains and food webs from Australian ecosystems, how producers, consumers and decomposers are related. **4.10c) ecosystems** Students learn to describe the roles of photosynthesis and respiration in ecosystems. **4.10d) ecosystems** Students learn to discuss some effects of bushfires, drought and flood on Australian ecosystems (p. 39).
Outcome 4.11 A student identifies where resources are found, and describes ways in which they are used by humans.
4.11a) natural resources A student learns to distinguish between natural and made resources. **4.11b) natural resources** A student learns to give examples of resources from living things and resources extracted from the air, Earth and oceans. **4.11c) natural resources** A student learns to identify fossil fuels and describe some of their uses. **4.11d) natural resources** A student learns to identify renewable and non-renewable sources of energy (p. 39).

One of the detailed Stage 5 *Outcomes* and one of the five *Prescribed Focus Areas* relates directly to the environment and eco-literacy:

> 5.3 A student evaluates the impact of applications of science on society and the environment (p. 16 & 30).
>
> In the Domain of *Knowledge and Understanding* in Stage 5 there are 61 outcomes. Two relate directly to the environment or environmental issues:
>
> 5.10 assesses human impacts on the interaction of biotic and abiotic features of the environment.
>
> 5.11 analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources (p. 16).

These outcomes are more explicitly detailed in the *Essential Content,* outlined in Table 2.8. The syllabus also has additional content, which was not examined in the now defunct Year 10 School Certificate examination. There is no requirement for this content to be taught, and these dot points are not numbered like those in the syllabus. The additional content is listed after Table 2.8.

Table 2.8

The Specific Content Related to Environmental Education in Stage 5 of the NSW Science Syllabus

Outcome 5.10 A student assesses human impacts on the interaction of biotic and abiotic features of the environment.
5.10a) ecosystems A student learns to distinguish between biotic and abiotic features of the local environment. **5.10b) ecosystems** A student learns to describe the importance of cycles of materials in ecosystems. **5.10c) ecosystems** A student learns to describe some impacts of human activities on ecosystems (p. 40).
Outcome 5.11 A student analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources.
5.11.1a) energy resources A student learns to discuss the importance of energy as a resource. **5.11.1b) energy resources** A student learns to identify properties that make some natural resources economically important and describe their uses. **5.11.2a) waste from resource** use A student learns to relate pollution to contamination by unwanted substances. **5.11.2b) waste from resource** use A student learns to identify excessive use of fossil fuels as a contributing factor to a greenhouse effect. **5.11.2c) waste from resource** use A student learns to discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality and sustainability of the environment (p. 40).

Natural events

- research evidence which supports the concept that Earth's surface and atmosphere have changed over the history of Earth. (p. 40).

Ecosystems

- discuss the Convention on Biodiversity with particular reference to Articles 8 and 10
- research how Aboriginal belief systems relate to environmental management

- discuss evidence for and against relating global warming to changes in weather patterns including El Niño and La Niña. (p. 40).

Resources

- discuss economic and environmental impacts of mining and resource exploration
- evaluate costs and benefits of various sources of energy, including those available to remote communities
- identify a variety of synthetic materials and relate their properties to their uses, e.g. plastics and some ceramics (p. 40).

Specific learning outcomes that relate to EE are also referenced in Section 3.2 where they have informed the design of the measuring instrument used in this study.

The examples outlined above serve to illustrate the crux of the problem. People today need to know a great deal about environmental issues, and yet NSW students don't study a lot about specific aspects of the environment. NSW teachers are guided more by the Syllabus to impart or support the development of attitudes and values towards environmental issues. Where is the linkage between the understanding of 'basic science' – the cycles in nature, the fundamental laws etc., and the holistic, integrated response needed in order to evaluate, as a scientifically literate citizen, the environmental issues raised daily in the media?

So is it possible to use the existing syllabus to apply an ESD approach? In the *Content* of the syllabus, the outcomes relating directly to ecology, resource use and the environment are laid out as has been described. However, the syllabus also states that "a context should be chosen after considering factors such as local resources and students' interests, learning history and cultural backgrounds" (p. 17) which means that teachers are free to set the context within which any of the syllabus content is delivered. The syllabus suggests that "contexts should be chosen to develop students' scientific literacy" (p. 18), and it could be argued that this applies as much to environmental

literacy as any other aspect of scientific literacy. This is especially relevant to the debates around sustainability as the syllabus suggests that "scientifically literate students' understanding of the nature and practice of science helps them to be questioning of claims made by others about scientific issues and be able to evaluate information presented from a variety of sources including popular media" (Board of Studies, p. 18). A teacher using an EE/ESD approach can contextualise any of the syllabus 'dot points' within sustainability issues, although this would realistically require a whole-faculty approach.

Additionally, each of the Prescribed Focus Areas (PFAs) must be addressed at some point in each year. The PFAs include History of Science; The Nature and Practice of Science; Applications and Uses of Science; Implications for Society and the Environment; and Current Issues, Research and Development. There is huge scope here for teachers to provide an EE/ESD context for content.

For example, students should develop an understanding of:

- the part that science has played in shaping society (p. 19);
- how science has been influenced and constrained by societies (p. 19);
- existing scientific views and evidence supporting these (p. 19);
- the processes and methods of exploring, generating, testing and relating ideas (p. 19);
- the stimulation provided by technological advances and the constraints imposed by the limitations of current technology, which necessitates the development of the required technology and technological advances (p. 19);
- the relevance, usefulness and applicability of scientific concepts and principles (p. 20);
- the use of science in developing technological devices and systems (p. 20);
- knowledge and understanding about the interrelatedness of people, their cultures and their biophysical surroundings (p. 20);

- skills in making decisions about issues, particularly those currently concerning society and the environment (p. 20);
- links between classroom experiences and their world (p. 20); and
- media coverage of scientific events (p. 20).

In addition, there are other curriculum documents and policies that assist students to achieve the broad learning outcomes of the curriculum framework and which are relevant to any consideration of EE/ESD. These include *Civics and Citizenship*, where students are required to "examine the local and global implications of current science issues, research and development on society and the environment. Through discussion and debate of current issues students may develop lifelong values and attitudes that underpin ethical behaviour and the desire and skills to actively evaluate the consequences of the applications of science." (p. 26).

The NSW Department of Education and Training *Environmental education policy for schools* (2001) has been mentioned, and the Science Syllabus refers to it by stating

> "Environmental perspectives are addressed through students' examination and consideration of:
>
> - Australian examples that illustrate the biodiversity and ecology of living things
> - the impact of human activities on the environment
> - the impact of applications of science on the environment
> - impacts on the biosphere of waste from resource use.
>
> Students develop their critical thinking skills and use creativity and imagination to propose solutions to scientific, technological or societal impacts on the natural environment. This reinforces the shared responsibility of all to conserve, protect and maintain the quality and sustainability of the environment for future generations" (p. 26).

It has been difficult to effectively teach EE using the current science syllabus, as it presents content grouped under traditional disciplines, while an EfS/ESD approach favours a broader, more holistic coverage of content. While a contextual approach has been encouraged, the author has only worked in one science faculty where programming was undertaken on such lines. It requires teamwork, leadership and a willingness to not teach to the topics traditionally favoured in textbooks to take such an approach. Careful planning is needed to develop a systematic and cohesive progression of learning across the years a student is studying at that school, and new ways to approach curriculum and content that are neither traditional nor mainstream.

2.4 Summary

This chapter has outlined how the concept of EE has evolved, from early ideas about education about the environment, to the emergence of Education for Sustainable Development; a developing educational paradigm which will have far reaching impacts on economic and social policy in the decades to come. Australian governments have been willing to embrace this global movement, but the implementation of EE policy has been fractured and slow, hampered by differences between the States and the inability of governments to plan and implement a national curriculum. Sustainability, while frequently lauded as 'essential', still has not found its way to the heart of approaches to teaching and learning in this country, and it seems likely that even the long promised National Curriculum will not see schools making the shift to fully embrace the principles of ESD.

CHAPTER 3

TEACHING EDUCATION FOR SUSTAINABLE DEVELOPMENT

3.1 Environmental Education Learning Theory

3.1.1 Education for Sustainable Development

> It is not an accident that our fragmentary form of thought is leading to such a widespread range of crises, social, political, economic, ecological, psychological, etc. in the individual and in society as a whole.
>
> Bohm (1980, p. 16).

As already outlined, Education for Sustainable development (ESD) is a concept that has crystallized as a result of international agreements and the global call to actively pursue sustainable development. It builds on and provides a new orientation for future practice in Environmental Education (EE). ESD attempts to move beyond education *in* and *about* the environment to focus on equipping learners with the necessary skills and motivation to be able to take positive action to address a range of long-term sustainability issues through process orientated active learning.

ESD motivates, equips and involves individuals and social groups in reflecting on how we currently live and work, in making informed decisions, and creating ways to work towards a more sustainable world. Underpinned by the principles of critical theory, ESD aims to go beyond individual behaviour change and seeks to engage and empower people to implement systemic changes.

Should Australian teachers wait for further policy direction, or a National Curriculum before re-orientating their curricula to address sustainability? UNESCO (2012) suggests that, ideally, efforts to reorient education will be based on national or local sustainability goals, and address local environmental, social, and economic contexts to ensure a curriculum that is locally relevant and culturally appropriate. However,

UNESCO also points out that to reorient an existing curriculum to address sustainability, educational communities need only to:

- consider the three components of sustainability – environment, society, and economy;
- identify the knowledge, issues, perspectives, skills, and values central to sustainable development in each and integrate them into the curriculum; and
- decide which sustainability issues (e.g. biodiversity, climate change, equity, or poverty) will be part of the curriculum.

During the long wait for a National Curriculum, the implementation of ESD in Australia has had a rather ad hoc approach; however there is no shortage of educational materials and approaches available to assist teachers in implementing ESD principles in their classrooms without delay.

UNESCO published a series of *Learning and training tools* outlining ways to implement ESD. One example suggests:

> At the classroom level, teachers can begin by explicitly stating the link between the topic in the mandated syllabus and sustainability. 'Today we are talking about international trade. Think about the shirt that you are wearing and where the fibre came from, where the cloth was made, where the shirt was sewn, and how it was transported to where you are. How much energy did that take? What is the carbon footprint of your shirt? How is your shirt related to sustainable use of resources?' From simple statements such as these, pupils will build their conceptions of sustainability and their knowledge of it (2012, p. 8).

From the point of view of the educator, ESD values democratic, learner-centred approaches, learning-by-doing processes, and seeks to engage and guide rather than lead and inform participants. ESD challenges teachers to get students to take control of their learning experience, digging deeply into the complex issues involved, then directing

their learning in ways that are of most relevance for them. The key aspects of this approach were summarised by Tilbury and Wortman (2004) and include:

- recognising, appreciating and reflecting upon individual and group definitions of quality of life and sustainability;
- envisioning a more positive future;
- actively working to achieve their vision of the future and moving towards sustainability using their personal, local and collective knowledge of the issues;
- exploring how their actions and values relate to other countries and the future of the environment;
- questioning how their assumptions are affected by their personal and cultural experiences;
- examining the societal structures that impede change and questioning the dominant social and structural institutions such as the capitalistic consumer culture;
- developing an awareness of how political processes work and how they can be influenced towards sustainability and equity, discovering avenues for long-term and broad-based participation in policy formation, decision making and implementation; and
- exploring how partnerships build a sense of community and global solidarity and examining the type of integrated partnerships that will assist in achieving sustainability.

The literature suggests that active learning approaches that are process oriented are most effective in helping students become motivated to engage in sustainability, by equipping them to achieve long-term sustainability outcomes.

Thus, there are a number of key pedagogical components, summarised in Table 3.1, that together form a mosaic of EE experiences in schools. No one theme should be used in isolation, but for the purposes of this discussion, each will be examined in turn.

Table 3.1

Summary of Pedagogical Components of Effective Education for Sustainability

Action Research	*Action research* can be used as a collaborative research tool, which aims, not just to improve, but also to drive, innovative teaching practices. It is often represented as a four-phase cyclical process of critical enquiry; plan formation, action/outcome, observation and reflection. Change is viewed as the desired outcome of action research and thus it can act as a catalyst for embedded change in systems leading to sustainable practices. Its focus on critical enquiry and continuous self-evaluation also makes it a useful tool for professional development in EE.
Adjectival Education	*Adjectival education* is a term used to describe other strands of learning such as citizenship education, futures education, global education and multicultural education. Adjectival education promotes cross-curriculum learning by exploring the linkages between society and environment and underpins 'critical' approaches to EE.
Capacity Building	*Capacity building* is the idea that more than pure knowledge needs to be developed to turn knowledge into action, and that skills also need to be developed.
Citizen Science	*Citizen science* is a participatory process that attempts to build public understanding of, and confidence in, science as well as support for scientific knowledge. It can be viewed as a process of social learning, relevant to all sectors, but particularly school students.
Critical and Cultural Thinking	*Critical and cultural thinking* is a method of examining issues that explores the power relationships in communities, schools, or workplaces and questions the motivations and interests of stakeholders.

Envisioning and Futures Thinking	*Envisioning and futures thinking* aims to achieve the development of attitudes that motivate students to achieve the vision of the future.
Experiential Learning and Action Learning	*Action learning* is a process where reflection and assessment are used to reach the goal of improved practice. The facilitator/mentor guides the process, which involves the development of an action plan, which is then implemented. Participants then reflect on what they have learnt as a result. The process works well in groups where a number of people come together to critically reflect upon how their professional knowledge and experience can be used to improve practice. *Experiential learning* is a constructivist approach to learning that uses contexts personally relevant to the participants in order to engage them in reflection, problem solving and decision-making. Participants are encouraged to actively construct their own knowledge, skills and values from direct experience. Experiential learning thus draws upon the knowledge of the learner, in addition to their understanding and prior experience, and involves the application of this knowledge to their current activities. Through reflection, feedback and the application of the ideas and skills to new situations and problems this process also provides opportunities for debriefing and consolidation of ideas and skills. Experiential learning differs from action learning in that participants are engaged in a specific, predetermined experience, such as an outdoor or nature based activity, rather than from past personal experience.
Systems Approaches and Systemic Thinking	*Systems approaches* aim to promote integrated thinking and decision making so that learners are able to understand the complexity behind sustainability. These approaches also enable change to be embedded.
Values Clarification and Issues Analysis	*Values clarification* is an approach that helps students to understand their worldview and why they value what they do and how they make decisions. *Issues analysis* helps students to identify major arguments related to a community problem; the perspectives and goals of the key stakeholders and assumptions related to that problem.

Western society's traditional approach to learning is based on a scientific worldview that attempts to simplify the world by viewing it in its individual parts. School education continues to be largely underpinned by an outcomes-based, individualistic approach that assumes that knowledge can be easily compartmentalised into subjects within a structured curriculum. In reality, much of the learning that occurs in schools happens in the social realm of the playground, or informal discussions with teachers and cannot be contained within categories, timeslots or prescribed hours. Bamford (1999) has examined how this dominant traditional approach to education no longer serves learners who need to understand and deal with complex and interrelated issues such as sustainability; hence new approaches to pedagogy need to be implemented.

3.1.2 Action Research

Since the mid-1980s the education methodology of *action research* has had a strong presence in the literature, and therefore within EE/ESD. Kyburz-Graber and Robottom (1999) suggest this approach is useful in "encouraging teachers to adopt a research perspective in gaining greater, more complex understanding of their own professional practices" and that this occurs in a context which is "not only different from the more conventional top-down, instrumentalist, competency-based approaches, it is also much more consistent with the particular characteristics of environmental education itself" (p. 289).

Traditionally, linear models often start and continue with a focus on knowledge. Learning acquired through action research is based on a cyclical process where students move along a continuum, acquiring knowledge as they plan, act, reflect and observe (Zuber-Skerrit, 2002) and this loop of continual 'critical reflection' aims at creating change. Thus, an action research approach engages students and teachers in an active and participative learning process that focuses on issues of student empowerment and curriculum improvement via action-oriented practice.

The methodology of action research develops skills and values in students that overlap with those of a systems approach or partnerships for sustainability approach. These have been identified by Huckle (1991) and Tilbury (1995) and include enquiry and

critical questioning, reflection on one's own actions, the ability to influence decision making through advocacy, political literacy and the democratic and social skills needed to work in groups to address and issue.

How does an action research approach work in practice? Collaboratively, teachers and students identify a relevant environmental or sustainability issue; pose questions to be explored; and develop an action plan. As the plan is carried out, both students and teachers observe and reflect critically on the process and outcomes. Students develop the essential skills to address environmental and sustainability issues while engaging with real issues. It is crucial that these action skills of participation and dialogue, negotiation, persuasion, partnership building, responsible consumerism, political and legal action, and eco-management are developed in students studying in a new paradigm of sustainability.

Action research projects in ESD also shift teacher-student relationships by challenging the traditional role of teachers as disseminators of information *about* the environment, towards a relationship with the students based on mutual respect and inquiry, so that throughout the learning process teachers and students consistently negotiate learning opportunities and the curriculum. As a result, teachers become the guides allowing students themselves to enquire into and reflect upon the real environmental issues within their community.

Tilbury (1995) has described how, in terms of action research within EE, the educational goal can be described as the improvement of the environment, and so action research can be a catalyst for school development towards sustainability. Also embedded within this holistic, interdisciplinary approach are the concepts of student empowerment and action for change, a sense of responsibility, and active student participation in learning about and addressing environmental issues. Tilbury (1999) suggests this "greatly contributes to the dynamic nature of the project as well as to developing project ownership and empowerment which are necessary ingredients for citizenship action" (p. 59).

In Australia, the literature about action research has challenged traditional professional development and teaching approaches in education, and specifically helped to promote a

more learner-centred and action-oriented focus in EE. The NSW Government's *Environmental Education Plan* called for "research into how best to develop organisational capacities and learning for education for sustainability, particularly through greater use of action research" (2002, p. 13). The potential of action research to promote school innovation, development and policy change towards sustainability is best demonstrated by the international work recently undertaken by the previously referred to OECD's *Environment and Schools Initiative* (2001).

The OECD's ENSI used curriculum development as a starting point to focus on integrating a culture of complexity, systematic thought and educational innovation into the whole school. This involved thinking about sustainability at the pedagogical, socio-organisational and technical-economic levels. The action research approach incorporated the active engagement of students in the learning process, leading to the development of 'dynamic qualities' (action-oriented and participatory skills), while also involving the wider community in developing change for sustainability.

Another international example demonstrating the potential of action research is the South African *Schools Water Action Project* (SWAP). SWAP was established in 1992, at the University of Stellenbosch and aimed to protect local freshwater catchments by engaging teachers, students, and communities in study and action. The action research component aimed to improve the quality of school and its curriculum experiences in two ways. First, by asking students to reflect upon, and take action to improve, their environment by addressing sustainability issues in the local catchment. Secondly, teachers were asked to reflect upon and improve their practice towards action-oriented learning.

In an evaluation of the project (Tilbury, 1999) concluded that SWAP was successful in stimulating pedagogical and curriculum innovation in EE. This approach had all the hallmarks of successful EE in that it:

- was interdisciplinary, taking a holistic view of sustainability issues;
- promoted the core values of sustainability;
- created opportunities for learning and change;

- shifted the role of the teacher from disseminator of information to a supportive co-learner;
- stimulated school-community dialogue and action through its hands-on practical experience approach to learning; and
- adopted a critical approach to EE, providing students with an opportunity to envision a better environment and society.

Action research was an instrumental tool in achieving these outcomes.

SWAP not only raised awareness of sustainability issues, but also led to mobilised action, including a clean-up of the river catchment areas and a cessation of the pollution from agriculture and industry. A marked increase in levels of community involvement in managing local resources was noted. The project demonstrates how the action research methodology ensures that learning is rooted in the real context of the local community where empowered, connected students *can* make a difference. The action orientation approach and the measurable, tangible environmental and social outcomes of the SWAP project make it unique internationally.

More recently, Reason and Bradbury (2013) have discussed how "action researchers may play a part in constructive large scale change" (p. 2). McNiff (2013) concurs that action research plays a significant role when common people "reclaim action research as their own, and create the kind of order they wish to have" (p. 190).

Participatory action research (PAR) has emerged in recent years as a way to bring about intervention, development and change within communities. It is used by international development agencies and community groups to understand the world whilst trying to change it, collaboratively and after reflection (Chambers, 2008).

A promising example of a PAR approach was outlined in a 2012 study by Burmeister and Eilks using a problem-orientated and socio-critical model of science teaching as outlined by Marks and Eilks (2009). They believe that, despite a poor public image, the chemical industry is making great strides in achieving sustainable production habits and end-products. Wheeler (2000) has discussed how studying the ways that chemistry can contribute positively to the design of sustainable communities, aid in the proper

stewardship of natural resources, and encourage sustainable economics means the study of chemistry can fit comfortably into an ESD framework. The specific lesson plan developed by a group of secondary school teachers aimed to teach students the chemistry needed to understand plastics, while simultaneously increasing the students' skills in understanding socio-scientific debates surrounding the production, use and disposal of plastics. Burmeister and Eilks reported that "students became increasingly contemplative with respect to both the environment and their personal decisions made concerning sustainability issues and available resources" (2012, p. 101).

In conclusion, environmental educators have used action research to explore the relationships between the student and the teacher, and the student and community. It is increasingly endorsed as a methodology in Australia and offers great potential for attaining both concrete environmental and educational outcomes while learning for sustainability.

3.1.3 Adjectival Education

Adjectival education is a term used to describe other strands of learning such as citizenship education, futures education, global education and multicultural education. The inclusion of these adjectival educations has broadened the scope of environmental issues taught in schools, and challenged traditional approaches to EE. UNESCO (2005b) called for a "holistic approach" (p. 4) to ESD in order to address some of the key themes of sustainable development such as poverty alleviation; citizenship; peace; ethics; responsibility in local and global contexts; democracy and governance; justice; security; human rights; health; gender equity; cultural diversity; rural and urban development; economy; production and consumption patterns; corporate responsibility; environmental protection; natural resource management; and biological and landscape diversity.

Tilbury and Henderson (2003) have noted that adjectival education promotes cross-curriculum learning by exploring the linkages between society and environment, global and local issues; as well as politics and power from an intercultural perspective. They

feel it also underpins ‘critical’ approaches to EE, commonly known as education *for* the environment.

As discussed earlier, education *for* the environment attempts to move beyond simply understanding about the environment to a point where learners are equipped with skills that will allow them to take action to address environmental issues. Such an approach promotes reflection about the issues underlying environmental issues, be they social, cultural or economic factors. The sustainability agenda is strengthening the type of socially critical approaches encompassed by adjectival education.

Initially, ESD was seen as a form of adjectival education (i.e. sustainability education to advance sustainability), however ESD is not just another adjectival education, which can get lost in the competition for a place in primary and secondary curricula beside fire safety education, disaster risk reduction education, human rights education, etc. There are adjectival education strands associated with pedagogical approaches to ESD such as critical reflection, experiential learning, systems thinking and values clarification; however ESD is an overarching paradigm that guides and transforms the core disciplines (mathematics, science, English and social studies) together with second-tier disciplines (art, music, health, life skills, technical and vocational education and training etc.) so that they can all contribute to moving towards more sustainable societies.

An example of an initiative that advances EE and ESD goals within an adjectival education framework is the *Global Perspectives: A Statement on Global Education for Australian Schools*. This document, prepared by the Curriculum Corporation in 2002, is future-focussed and emphasises core themes such as unity and interdependence, empowerment, social progress and sustainable development. It promotes a whole school approach, promoting this learning across the curriculum and in all years from K-12. It does not seek to prescribe curriculum content; rather it seeks to act as a philosophical and practical reference point for Australian teachers by laying down the goals, rationale, emphases and processes of what is referred to as *global education*.

3.1.4 Capacity Building

Capacity building involves the idea that more than 'pure knowledge' needs to be developed to turn knowledge into action, and that skills also need to be enhanced. Capacity building in ESD involves programs or initiatives that support people through an educational process that builds the skills needed to engage in change towards sustainability. The process of capacity building may involve thinking systemically, challenging assumptions, critically questioning situations, articulating visions of the future and definitions of locally relevant sustainability. The desired outcome of the skills building process is that the effectiveness of individuals, organisations and systems to define or achieve outcomes through strengthening their knowledge base, competence, resources, networks, infrastructure and other forms of support is enhanced. Thus, structural or institutional change within mainstream society is achieved as people guide, direct, and empower themselves.

3.1.5 Citizen Science

> Participation is vital for democracy and sustainability. Changes that support sustainability are more likely to be implemented if people have a clear understanding and commitment to them.
>
> NZ Parliamentary Commission for the Environment (2004, p. 44)

> A key aspect of citizenship education within the context of sustainable development is international understanding. This helps bring an understanding of the links between local and global issues. It also means that people can be given opportunities to examine their own cultural values and beliefs, to appreciate the similarities between peoples everywhere, to understand the global contexts of their lives, and to develop skills that will enable them to combat prejudice and discrimination.
>
> UNESCO (2002, p. 21)

Citizen science emerged out of the USA at a time when the public was beginning to distrust scientific evidence and becoming critical of the role of scientific institutions in

addressing and managing risks in society. Leach and Fairhead (2002) defined citizen science as "an attempt to take science out of the laboratory in the sense of being conducted within a wider social context" (p. 301).

Thus citizen science is a process of participation that attempts to impart scientific knowledge, at the same time as building public understanding of the role of science. It aims to restore public confidence in the role of science, but also to assist with understanding how complex and interrelated aspects of science underpin a concept such as sustainability. Bäckstrand (2003) advocates citizen science and sees it as a process of social learning, both for the researcher and the community, stating "participatory, civil, citizen, civic stakeholder and democratic science are catchwords that signify the ascendancy of participatory paradigm in science policy" (p. 2).

Jenkins (1999) has defined citizen science as "a form of science that relates in reflexive ways to the concerns, interests and activities of citizens as they go about their everyday business" (p. 704). Roth and Lee (2002) relate citizen science to a range of activities, many of which fall under the umbrella of environmental concerns, such as accessibility to safe drinking water, best farming practices, sustainable or organic gardening methods and activism. Defined this way, citizen science presents a natural fit with EE.

Within Australian schools, many EE programs underpinned by approaches to citizen science involve students in collecting scientific data within their local environment. Through programs such as *GLOBE*, *Waterwatch*, *Saltwatch*, *Streamwatch*, *Frogwatch* and *Airwatch* students, collect data about water or air quality and biodiversity. This actively involves students in learning about the scientific information that directly affects their communities.

The data collected in these programs have two purposes. Not only do students observe changes over time in their local environment, and make comparisons with other regions, but also the data are pooled by the co-ordinating organisation and used for analysis. These organisations include publicly funded, non-profit organisations such as Waterwatch Australia, Saltwatch, and Airwatch Australia, as well as the government agencies Sydney Water (Streamwatch), the Western Australian Museum and the

Australian Government Department of the Environment. These programs are relatively inexpensive and allow for broad data collection that can be used for a variety of purposes.

Streamwatch, for example, began in NSW in 1990 and is run in partnership by Sydney Water and the Sydney Catchment Authority (SCA). Streamwatch groups across Sydney, the Blue Mountains, the Illawarra and Southern Highland regions investigate and take action on water quality and catchment and ecosystem health. Over 250 community and school groups monitor water quality and macro-invertebrates across more than 600 sites. The program has strong quality assurance elements built in so that results are technically sound, reliable and useful.

Sydney Water uses the data collected in the Streamwatch program to raise awareness about water issues with local government, businesses and industries. The information collected also has the potential to trigger community concern about the state of the local environment. Streamwatch can be integrated across many KLAs in the school curriculum, helping schools achieve syllabus outcomes and meet requirements of the NSW *Environmental education policy for schools*. Streamwatch can also be run as an extra-curricular program. The author has used the Streamwatch testing kit as part of an extra-curricular environmental group, and separately to conduct the mandatory experiments in the Stage 6 Chemistry core module *Monitoring and Management*.

It is a valid criticism of the program that it is often used by schools in such ad hoc ways. Even when run over a period of time it does not typically provide the school with an opportunity to analyse and use the data to motivate community action towards sustainability. In contrast, a small number of programs are emerging that ensure the data generated remain with the students and the school. *MYRiveR* is one program that provides opportunities for students to develop a vision and action plan for their local river. Participation in this program, it is hoped, develops in students an understanding of their local environment and the associated sustainability issues, as well as a sense of belonging and responsibility towards local environments.

MYRiveR is an OzGreen program run by the Global Rivers Environmental Education Network Australia, an independent, non-profit organisation. In this program, young people and their communities conduct 26-point health checks involving water quality testing, surveying community attitudes and environmental assessments of biodiversity, erosion and vegetation cover at various sites in their local area. Participants interpret the results to determine the health of the river and the factors impacting on it. From this they develop a vision and action plan and communicate their findings at community forums. This allows young people to play a strong leadership role and aims to involve the whole community in identifying issues of concern and community-wide action plans.

Students are engaged throughout the whole process. The knowledge they gain empowers them for change, and they become instrumental in the decision-making to improve the catchment. In such programs, however, there is an in-built assumption that raising awareness will result in change for sustainability. In MYRiveR students are encouraged to develop an understanding of their local environment and the sustainability issues surrounding it. The results are presented to the community and the expectation is that because they are now aware of the problem, change will occur. Given the intransigence of the environmental problems in Australian river systems, such as the Murray-Darling Basin, the hope that student activism will lead to lasting, community-wide change is clearly an optimistic approach.

OzGreen has worked with villages and community organisations in India, Papua New Guinea, East Timor, Nepal and the Mekong River Basin and involved 150 schools in testing 400 sites. 5000 companies have been surveyed and 600 businesses and schools have been involved in pollution prevention training; audits and action planning; and sustainable living education programs involving hundreds of residents.

Such achievements are impressive, but while students may be inspired to act, if they are not provided with the skills or understanding of existing systems and structures they will be limited in their ability to participate in decision-making for change. If the students are not effective in communicating to the community the competencies required for

action, the likelihood of engaging the community in decision-making or change for sustainability is further reduced.

International agreements, such as *Agenda 21 (1992)* and *Plan of Implementation of the World Summit on Sustainable Development (2002)* have recognised the importance of democratic decision-making processes and the need for the redistribution of power inequities as keys to sustainability. Webler, Kastenholz, and Renn (1995) and Lyons, Smuts, and Stephens (2001) have discussed how *all* those involved must feel empowerment, participation in, and ownership of, the processes if higher levels of competencies for change are to be achieved. Tilbury (2003) has also discussed how the importance of student ownership, control of learning and engagement in community processes of decision-making is increasingly being recognised in EE as key to change for sustainability.

Roth and Lee (2004) state that science educators should seek out real life community situations that allow a variety of participatory roles, "more consistent with a democratic approach in which people make decisions about their own lives and interests" (p. 267), rather than expecting schools to provide students with knowledge and an expectation that they will apply it in the 'real world' at some later date.

If they are to contribute to ESD and benefit sustainability, *citizen science* approaches must actively engage students *in* the community, and allow them to:

- present data findings on sustainability issues;
- communicate proposed courses for action by the community; and
- participate in democratic decision making

3.1.6 Critical and Cultural Thinking

> One of the central platforms to critical thinking is that the world cannot be changed rationally unless it is interpreted adequately.
>
> Huckle (2004, p. 33).

> Environmental problems result from environmental practices and environmental practices are cultural activities…..we need to teach how culture works, because cultural differences frame what are seen as rational arguments.
>
> Saul (2000, p. 7).

Critical thinking is an essential part of EE/ESD and is a process that involves questioning the world around us, how society is shaped by us, and how we are shaped by society. This approach can be used to interpret the root causes of local and global problems, to challenge bias, and support rational decision making, challenging participants to examine the way the world is interpreted and how those around us shape our knowledge and opinions. As a result of this process, a deeper understanding of the influences of media and advertising, the interests behind our communities and the homogenising effect of globalisation on culture is gained.

The critical thinking process involves repeatedly asking the question 'why' until participants have fully explored the issue. Critical reflection follows, and involves learning from the questions and answers generated during the critical thinking process. The knowledge generated as a result can be used to effectively engage in sustainability. Critical thinking and reflection can also be of assistance when evaluating the effectiveness of programs in EE.

World Wildlife Fund UK (WWF) commissioned the *What We Consume. Global Environmental Education Programme* in 1993, which used critical reflective questions to examine environmental and sustainability issues. The program was framed around a list of critical questions in the areas of Economic Production; Distribution and Redistribution of Resources; Power and Decision-making; Social Organisation; and Culture and Ideology. The resource included the modules What we Consume; Society and Nature; and Environment and Democracy which dealt with issues such as advertising and nature, influencing decision-making and understanding cultural lenses. The material was presented in a way that engaged students in active processes of analysis, questioning, discussion and decision-making.

Closer to home, the 2004 *Our Environment - It's a Living Thing* (OE-ILT) Professional Development Program was based on critical thinking to help increase the understanding of the ESD concept, but was found by Tilbury, Garlick, and Henderson (2004) to have had mixed success; highlighting the need to build some teacher and executive's skills prior to its application in schools. The OE-ILT program itself, by contrast, was deemed by Collier (n.d.) to be innovative because it was a large, community based program that was research and evaluation based.

3.1.7 Envisioning and Futures Thinking

> If it is true that all education is for the future, then the future needs to become a more explicit element in all levels of education. As education for sustainable development is education for a future that we cannot yet predict, it is important that education programmes seek to develop skills for understanding and anticipating change and for facing the future with courage and hope. This would involve coming to realise that the future is a human creation, made by our decisions, and that in a democratic society, people have the right, indeed an obligation, to contribute positively to a sustainable future. This would involve learning how to learn, how to analyse and solve complex problems, how to think creatively and critically about the future, how to anticipate and make our own histories. These contribute to the skill of foresight and are all aspects of a futures orientation in education.
>
> UNESCO (2002, p. 20).

Envisioning a better future, also known as *futures thinking*, is a process that engages people in conceiving and capturing a vision of their ideal future, helping them to discover their possible and preferred futures, and to uncover the beliefs and assumptions that underlie these visions and choices.

As outlined in the quote above, futures thinking is a core theme in reorienting education towards sustainability, through the development of attitudes which motivate students to achieve their vision of the future, by establishing a link between their long term goals and their immediate actions. Envisioning offers direction and energy and provides an

impetus for action by harnessing the deep aspirations that motivate actions in the present.

3.1.8 Experience, Experiential and Action Learning

> A school … does not become 'green' by conserving energy, collecting batteries or sorting waste. The crucial factor must be what the students learn from participating in such activities.
>
> Schnack (1996, p. 1)

Experience

A key component of traditional EE has included providing opportunities for students to have experiences in direct contact with the natural environment. Some Environmental Education Centres (EECs) in Australia have based their work on Van Matre's *Earth Education Programs* (1979, 1988, 1990) and Cornell's (1979) work in the long tradition of using outdoor experiences in education to attempt to build an awareness and wonder of nature among students. Such experiences can include participating in activities at EECs, national and state parks, heritage sites, farms, zoos, museums and beaches.

Many environmental educators have argued that significant life experiences in the environment are important in developing attitudes and towards the environment. Such experiences are a rarity for many children nowadays. Hofferth and Sandberg (2001) have reported that children living in the USA today spend an average of just thirty minutes of unstructured time outdoors each week. Increasingly, children spend time indoors watching television, playing video games, and using computers. They found that children aged three to 12 spend just one percent of their time outdoors, but 27 percent of their time watching television. The United Nations Population Division reports that almost 50 percent of the world's population now live in urban areas and this is projected to increase to 65 percent by 2030. Increasingly, schools are the sole means of providing children with experiences in nature. Some of the research that has examined the influence of childhood contact with nature on environmental behaviours in later life is summarised below.

In the first study of its kind, Tanner (1980) asked 45 dedicated conservationists to describe formative influences in their lives. Of the individuals who specified the influence of outdoor activities, hunting, fishing and bird watching during childhood or adolescence were activities most often mentioned. In subsequent studies, Peterson and Hungerford (1981) and Corcoran (1999) posed similar questions to environmental educators in the United States; Palmer (1993) studied environmental educators in the UK; Chawla (1999) conducted open-ended structured interviews with environmentalists in the USA and Norway; and Sward (1999) studied El Salvadoran environmental professionals. The single most important influence on individuals that emerged from these studies was many hours spent outdoors in natural habitats during childhood or adolescence, be it alone or with others. Also important were the influence and example of parents, teachers and other adults who fostered an interest in nature via activities such as scouting, camping or fishing. Other important childhood experiences included witnessing the destruction or alteration of landscapes or habitats and accessing media or books.

Studies involving the environmental attitudes of children have also been undertaken. In 1982 Jaus examined the effectiveness of a ten-week EE program undertaken by fifth graders and found significant differences in the environmental attitude scores of the participants compared to a control group of students who did not take part in the program. When the control group subsequently undertook the same instruction, they also showed significantly more positive environmental attitudes, compared to their pre-test results.

Kellert (1985) concluded that children who primarily learned about animals in the context of school or at the zoo were generally less appreciative, less knowledgeable, and less concerned about animals than were children who engaged in bird watching, hunting, or belonged to animal-related clubs. Ramsey and Hungerford (1989) found that an Issue Investigation and Action Training program undertaken by children in the seventh grade led to significant changes in both overt environmental behaviours and in outcomes related to knowledge and sensitivity.

Chipeniuk's (1995) research examined links between childhood foraging and later environmental knowledge and reported that people who had as children foraged the greatest breadth of flora and fauna (such as seedpods, fish, turtles and insects) had, as teenagers, a better knowledge of biodiversity. Lohr and Pearson-Mims (2005) examined the influence of childhood contact with nature and attitudes toward plants as adults. Children who grew up with gardens and who undertook activities such as picking vegetables, planting trees, and taking care of plants were found to have beliefs as adults that 'trees are calming' or 'trees have personal meaning'. Other predictors included having spent time outdoors with trees or in parks during childhood.

Ewert, Place, and Sibthorp (2005) examined the links between outdoor experiences in childhood and environmental attitudes in early adulthood. They surveyed undergraduate students and found that participating in appreciative outdoor activities (time outdoors enjoying nature), consumptive outdoor activities (hunting and fishing), media exposure (books and television), and witnessing negative environmental events during one's youth were predictive of eco-centric rather than anthropocentric beliefs in later life. Together, these studies suggest that children's playtime and other experiences in the natural environment do impact on attitudes, knowledge, or behaviours towards the environment in later life.

Wells and Lekies (2006) set out to examine if it is true that early experiences are important in putting a person on a trajectory towards environmentally conscious behaviours and attitudes in later life. They used structural equation modelling to examine long-term linkages between childhood nature experiences and adult environmentalism among a large, representative sample of adults from the general population. They report that "the most direct route to caring for the environment as an adult is participating in 'wild nature' activities before the age of 11" (p. 13), as people who engaged in these kinds of activities as young children were more likely as adults to express pro-environment attitudes and to indicate that they engaged in pro-environment behaviours. 'Wild nature' activities include bushwalking, camping and hunting or fishing, and were found to be positively associated with environmental behaviours. 'Domesticated nature' experiences such as picking flowers or produce, planting seeds

and caring for plants were found to be positively associated with environmental attitudes, although only marginally related to environmental behaviours. These findings suggest that ESD is particularly important in primary school, which is encouraging, as it is more easily incorporated into existing curricula at the primary school level, and activities such as kitchen gardens, recycling, composting and keeping chickens are already well established in many primary schools.

Significant life experience research, however, has been criticised by Gough S. (1999) for basing its research predominantly on environmental activists; by Gough A. (1999) for sampling of an older generation that may not necessarily represent current generation's interest or motivations; and for the lack of gender and cultural considerations in research data; and by Payne (1999) for the ambiguous way the natural environment is considered.

In addition, Wells and Lekies (2006) reported that some of their findings were contrary to their hypotheses and inconsistent with prior research. They found that participation in EE programs in schools, with Scouts, at camp, or in community environmental improvement programs was not a significant predictor of either environmental attitudes or behaviours. They speculate that this may be a reflection of the impact of relatively structured modes of EE, rather than more engaging, hands-on versions that may be more likely to have long-term impacts.

Nonetheless, Charles and Louv (2009) concluded that although the relationship between children and nature has not been studied thoroughly in any context or country, the body of research is generally consistent and provides "insights into both the indicators of the nature deficit in children's lives, and the benefits to children's healthy development by direct experiences with nature in their everyday lives" (p. 2) and that enough is understood for action to occur.

In general terms, what is understood is that:

- Direct experiences in nature are diminishing across many countries, as children spend less time playing outdoors, have less discretionary time, are more sedentary and spend more time with screens and other forms of media (Kellert (2005), Clements (2004), The Outdoor Foundation (2008), Singer, Singer

D'Agostino & DeLong (2009), Hofferth & Sandberg (2001), Roberts, Foehr & Rideout (2005) and Brown, Pfeiffer, McIver, Dowda, Addy, & Pate (2009));

- As children's access to public play spaces has declined, and limits are placed on what they may do in such spaces, many children spend most of their free time indoors and supervised (Wridt (2004), Karsten (2005), Hillman, Adams & Whitelegg (1990) and Tandy (1999));
- Families are less likely to visit national parks and wilderness areas, children have little contact with nature and are more familiar with the attributes of characters in video games than with common plants and animals (Verboom, van Kralingen, & Meier (2004), Pergams & Zaradic (2006 and 2008), Balmfold, Clegg, Coulson & Taylor (2002), Bebbington (2005), Turner, Nakamura & Dinetti (2004), and Lindemann-Matthies & Bose (2008));
- Adolescents' levels of concern for the environment have diminished since the early 1990s (Wray-Lake, Flanagan & Osgood (2009)).

The bulk of the studies have found that positive environmental attitudes and behaviours associated with experiences in nature result from childhood experiences carried out primarily in the home and family environment, rather than via formal educational settings. For this reason, this thesis measures the experiences of students in both the school and home setting.

The validity of this research is therefore mixed and the idea that merely experiencing the natural environment leads people to engaging in positive action for the environment is still an open question. There is at this stage insufficient empirical evidence to suggest that an experience of the natural environment leads to greater participation for change towards sustainability.

Experiential Learning

It has been suggested by Law (2003) that *experiential learning* can empower learners by developing awareness and encouraging feelings of responsibility and ownership towards the environment through engagement in constructing knowledge, values and skills from direct experience and in personally relevant contexts. Such experiences are supported

by feedback, reflection, critical analysis and the application of the ideas and skills to new situations.

Experiential learning takes many forms, ranging from scientific predict–observe–explain situations to drama and creative art. Indeed, experiential learning does not even require a direct experience with the physical environment, but the process leads, in practice, to the testing and evaluation of ideas and challenges the values and attitudes of the learner as they reflect on the learning experience.

Experiential learning is often associated with adaptive management techniques and involves four phases (Kolb, 1984):

- *Concrete experience*: Where a learner engages in a particular experience and observes its effects.
- *Observation and reflection*: Where a learner processes the experience to understand what was done, thought and felt during a learning experience.
- *Forming abstract concepts*: Where the learner develops the cause and effect relationship behind the action or experience, or understands the general principle between an action and its effects.
- *Testing in a new situation*: Where the learner applies the principle or generalisation to a new situation.

Experiential learning has the potential to greatly impact on ESD. The characteristics of reflection, connection to personal experience, emotionally engaged learning and student-centred teaching and learning were found by Law (2003) to combine and lead to higher levels of student interest, motivation and enthusiasm for achieving social action. Experiential learning for social action is also referred to as *action learning*.

Action Learning

Action learning was first identified in the educational context by Revans in the 1940s (cited in Koo, 1999) and is defined by Zuber-Skerritt (2002, p. 115) as "a process by which groups of people (whether managers, academics, teachers, students or 'learners' generally) address actual workplace issues or problems, in complex situations and

conditions". Action learning is therefore distinguished from experiential learning in its focus on a single issue of concern.

Although it can be just as effective when done individually, action learning is usually undertaken in collaborative groups, such as classes. Thus, actions with others and from others inform the learning and there is generally a specific focus to the learning. The learners are engaged in a repetitive process of critical questioning resulting in a second loop of reflection. Participants are given ownership over the learning experience and a personal commitment to change is required, and thus self-direction for further learning experiences is provided. As Orr (1999) has identified "the way of the future will require the reintegration of experience into education, because experience is an indispensable ingredient of good thinking...an antidote to the despair felt by students who understand problems but are powerless to effect change" (p. 232).

An example from outside the school sector of how such a program might work is the 2004 *Our Environment: It's a Living Thing Program* (OEILT), funded by the NSW Government. This (ongoing but less active) program was an initiative of the NSW Government to support partnerships with local government, community organisations, businesses and individuals across the state.

The mentoring component of this program consisted of a six-month structured support program that followed the ILT Education for Sustainability Professional Development Workshops. Community educators were invited to participate in a professional development program for sustainability and used action learning to build their capacity to implement change in the workplace or community educational programs they implemented. The process of reflection-on-action assisted the community educators to make changes to their education programs toward ESD. The educators were required to identify a change focus for the program, develop an action plan to achieve these changes, act upon the plan and then critically reflect on the process to learn from the action and plan for the next stage. Tilbury and Ross (2006) outlined how the project evaluation showed that the process was effective in supporting educators as they applied the LfS approaches to their existing workplace programs.

Despite action learning now being integrated into a number of workplace sectors there is scant documented evidence of it in Australian schools. Nonetheless, over the last ten years action-oriented approaches have increasingly been featured in the goals of EE programs. These approaches, discussed in Hungerford et al (1990, 1992) and Winther, Volk and Hungerford (1994) have assumed that EE learning is a problem-solving process, which actively encourages the learner to be reflective and responsible for their actions in the environment. These approaches have been found to endorse real and simulated actions including negotiation, persuasion, consumerism, political, legal and eco-management (Tilbury, 1995).

In practice, the reflective component of action-orientated approaches has often been neglected, and replaced by 'hands on' environmental actions such as planting trees or recycling paper, which obviously lack a reflective component. For example, *Schools Clean Up Australia Day* is held in Term 1 each year (Clean Up Australia Day, 2011). This involves students cleaning up rubbish in their own school grounds or alternately being transported to local litter 'hot-spots'. Students are provided with gloves, bags and the motivation to contribute to local environmental improvement. The fact that the nation's largest community based environmental event has taken place every year since 1990, has over 6000 registered clean-up sites, and collected thousands of tonnes of rubbish at this year's event suggests that, however much goodwill the event generates, the environmental problem is as intransient as ever. The behaviour of individual participants might change, but the behaviour of the community has not.

An initiative of Planet Ark that aims to get Australian students involved in planting trees is *Schools Tree Day* (n.d.). This is also a one-day event, which provides an opportunity for students to have 'hands-on' experience in the local environment and in 'eco-action'. It can be argued that both these programs have immediate tangible environmental outcomes; however such activities need to go beyond issues of litter or tree planting to waste management, consumption and habitat destruction. Until this occurs it is difficult to ascertain the educational value of activities which are not linked to any curriculum outcomes, and do not encourage critical thinking or reflective practice. The actions of collecting litter or planting trees are not the result of a process of choice or an

exploration of the complexity of the issues. These initiatives, although worthy in themselves, result in environmental outcomes that are often not sustainable because they do not deal with the underlying issues at the core of the problems. Jensen and Schnack (1997) have argued that this superficial approach does not allow students to comprehend the complexities of issues or feel they can be an influence for change, and can, in fact lead to what they call '*action paralysis*' which causes many students to disengage from environmental issues.

As Gough (1997, p. 77) points out; "although the environmental content of school curricula has increased, most schools are not involved in education for the environment… (schools are) incorporating environmental content (knowledge and awareness) into their existing curricula rather than engaging in the kinds of social action that are being undertaken by other community agencies and activists". The dimensions associated with action oriented approaches in theory; educational (reflexive), the social (cooperative negotiated action) and political (involvement in decision making), have been diluted in practice. Commentators such as Jickling (1992, 1997) have therefore argued that education *for* the environment (associated with this action orientation) equates to agendas and actions being prescribed, or worse, coerced. As learners do not think or reflect for themselves, the educational outcomes are not achieved.

Researchers, such as Hungerford and Volk (1984, 1990), made significant contributions to promote action orientated objectives through EE throughout the 1980s and early 1990s. Their work featured in the UNESCO-UNEP *International Environmental Education Program* (established 1975), which had a strong focus on problem solving as the basis for environmental action. Learners were encouraged to engage with issue identification, investigation and problem solving (Winther, Volk, & Hungerford, 1994).

Such an approach can, however, mislead students to believe that all environmental issues can be simply 'solved' through problem-solving approaches. As most environmental issues are complex, and often cannot be 'solved' as such, the best that can often be hoped for is for the impacts to be ameliorated or lessened. For students to understand this, they must develop an understanding of this complexity and the limits of simple 'cause and effect' analysis.

Nonetheless, the work of Hungerford and Volk has led to the development of an *action competence framework* that has challenged environmental educators to consider:

- the role of democratic engagement in learning;
- the need for understanding the context in which action is to be taken;
- the development of reflection and critical decision-making as part of the skills needed for action to occur.

The action competence framework is seen as critical to effective student participation for change. In this context, action research can help bring about systemic change within schools so they are more aligned with the concepts and processes of sustainability.

The action orientation of ESD has also been considered by the OECD's *Environment and Schools Initiative* (ENSI, 2001). Their interpretation is premised on the concept of ESD as an interdisciplinary study and the ENSI promotes 'dynamic qualities' as opposed to 'actions', in which students do not passively appropriate knowledge but rather actively construct it. This constructivist approach leads to a significant difference in the way the process of action is implemented and has implications, both for the way students understand and come to know, and for the way teachers teach.

Janse van Rensburg (2000) has described how this approach encourages active participation by democratic learning and decision-making and the use of dialogue to construct knowledge. Thus, 'action' does not take place in the environment, but in learning. Students assume ownership over the project as they actively construct their own understanding of environment and sustainability issues, learn independent and reflective thinking and take control of their learning and actions. As learners, they build their capacities for developing a more complex collective understanding of issues and actions. As a result, students become active, rather than passive, participants in a learning process that generates an action orientation as well as an understanding of the responsibility associated with action taking.

In the second order action research approach used by ENSI, knowledge is related to spheres of socially important action and students are encouraged to investigate and question the assumptions and values around controversial issues. The dynamic qualities

promoted by ENSI include the ability to think independently, work cooperatively and reflect upon all the processes within a school environment, thus encouraging reflexive and responsible action in the face of complex scenarios. The OECD ENSI has been instrumental in affecting innovation and school development, by developing intra- and inter-national networks for teachers, researchers and policymakers. New dialogue, participation and partnerships amongst stakeholders have been encouraged, effecting structural change in schools and educational institutions.

The success of such measures may prove difficult to assess. Eames, Barker, Wilson-Hill, and Law (2010) attempted to develop a framework capturing the six aspects that indicate the development of student action competence: experience, reflection, knowledge, visions for a sustainable future, action taking for sustainability, and connectedness. They concluded that it was neither "possible nor appropriate" (p. 5) to develop a matrix to be used to measure a school's success in implementing an action competence framework.

3.1.9 Systems Approaches and Systemic Thinking

> Whilst critical thinking is concerned with ideology, power, and justice, systemic thinking is concerned with assumptions, pattern and relationship. Systemic thinking can instil a sense of appreciation, humility, and empathy – a recognition that sustainability issues often require a shift from a culture of control to one of participation and cooperative working.
>
> Sterling, 2004a, cited in Tilbury & Wortman, 2004, p. 84)

Often decisions in one area of society are made before fully understanding the adverse impact on other areas. Simple problem-solution approaches often lead to an incomplete and imbalanced approach to thinking about the world, particularly the increasingly complex issues of sustainability. *Systemic thinking*, however, encourages participants to look at sustainability issues and society and to think holistically about how change in one affects the other.

Definitions of ESD consistently refer to an interdisciplinary, interconnected approach that views the environment in its entirety; linking the local to the global, the natural to

the human environment and the power of the individual to the community. As such elements are also characteristic of a *systems approach*, pedagogical approaches to ESD are increasingly influenced by systems approaches and systemic thinking (Federico, Cloud, Byrne, & Wheeler, 2003) which recognise that a meaningful understanding of environments and sustainability concerns comes from building up whole pictures of phenomena and understanding of relationships, rather than focusing on dividing concerns into smaller parts.

Systems approaches have underpinned thinking and practice of EE since its earliest days. In 1977, the world's first intergovernmental conference on EE, called for the need for a "holistic approach, rooted in a broad interdisciplinary base" to create "an overall perspective which acknowledges the fact that natural environment and man-made environment are profoundly interdependent" (UNESCO-UNEP, 1978, p. 1). This guiding principle continues to be embedded in the authoritative international EE/ESD literature including documents from the Johannesburg Summit in 2002 which stated that "the vision of education emphasizes a holistic interdisciplinary approach to developing the knowledge and skills needed for a sustainable future" (UNESCO, 2002, p. 10). This concurs with the Gaian Theory, espoused in 1979 by Lovelock in *Gaia: a New Look at Life on Earth,* and the work of Capra, who in his 1996 book *The Web of Life* promulgated the need to recognise that we live in a systemic world.

Sustainability issues are multi-dimensional and suited to systems approaches, which focus on more than merely learning the components of a situation or issue, but with understanding the relationships and linkages between them. These approaches promote non-linear learning, leading to a more complete understanding of the situation. As Stirling states, "systemic thinking promotes learning that demonstrates the interdependent complex relationships between the physical, social and economic environments" (1996, p. 5). An example might be the links between a lifestyle issue, such as consumption, and resource use, wealth distribution, consumerism, advertising, personal responsibility, globalisation and waste management issues i.e., how does what we do on a daily basis contribute to the system?

Sterling (2004b) further outlines how this way of thinking and learning does not box areas of knowledge into categories, but promotes an understanding of the interdependent relationships and complexities of the world we live in and recognises that much of our learning occurs by reflecting upon knowledge and experience, regardless of where the learning takes place. Systems approaches to education attempt to recognise the interrelationships and complexity of our participation in the world, and to support educational changes that develop interdisciplinary, participative learning and links between schools and communities.

Posch (1990) and Tilbury and Turner (1997) have examined how, in order to take students outside curriculum boundaries, there have been attempts to partner schools with the local community, councils, industries and community action groups to address local issues. By engaging with the local community in real projects, students are exposed to the complex reality of environmental issues. In whole systems thinking, there is a focus on understanding the interconnections and interdependence between all things. When students are exposed to the different skills and insights that different partners bring to the table, connections and relationships develop which add to the understanding of the whole system.

Systemic thinking challenges traditional approaches to education, particularly science education with its focus on specialist disciplines, and thus challenges behaviourist approaches to ESD. If a systems approach is taken to ESD it requires a fresh way of looking at schools, curriculum, professional development and partnerships between schools and communities. Systemic thinking calls for a move away from a fragmentary and reductionist view of knowledge and the world, towards a relational and integrative view. Such an integrated understanding is difficult to teach within current curricula.

Sterling (2004a) points out that there has been a lack of systems approaches and insufficient resource materials that would supply the necessary tools to demystify such approaches. A single teacher cannot sustain change; change must be rooted within the school. A school cannot become sustainable unless the structures and management systems needed are in place to support it. Thus sustainability needs a systems approach,

not only at the school level (facilities, operations, supplies and management), but also for the whole education system itself.

However, despite Australian curricula using a key learning curriculum framework with fixed boundaries segregating the various areas of the curriculum, it is possible, especially for primary teachers, to adopt a broad, holistic approach to lesson content and to incorporate sustainability practices, not only into classroom activities, but beyond the classroom and into the school administrative practices and the community beyond. Generic skills such as research, communication, problem solving, cooperation, citizenship and using technology can all assist teachers in taking a systemic approach to their planning and teaching.

Two international examples give a clue to how such approaches might be implemented in education systems. In 1998 the English Government's *Sustainable Development Education Panel* was set up in order to provide advice and develop an ESD framework with strategies to promote and support learning for sustainability. Interdependence was one of the key principles identified by the panel and they argued it was critical to constructing an understanding of sustainability to learn that "major issues such as poverty, consumption, development, health and loss of species are interrelated". If change for sustainability is to occur students must also understand the interdependence of one's choices, actions and understanding of the inter-related concepts such as "the tension between sustainable development based on local production and consumption and the globalisation of trade and finance" (Department of Education and Skills, UK, 1998, p. 5).

ESD programs such as the WWF Scotland's *Linking Thinking*, explicitly teach the skills associated with thinking in an inclusive, integrative, systemic and holistic manner. *Linking Thinking* introduced systemic and relational thinking concepts and skills which encouraged clarity and overview when dealing with complex and difficult concepts such as sustainability. As Sterling points out "*Linking Thinking* emphasises that we live in a highly connected world….it makes sense to recognise and try to understand the systemic connection and possible consequences of our actions" (2004b, p. 230).

In Australia, *Hands on For Habitat* was an EE resource developed by the Natural Heritage Trust and Cadbury Yowie. A national poster competition and Hands on for Habitat Awards promoted National Threatened Species Day activities. The first National Threatened Species Day was held on 7 September 1996, to commemorate the death of the last Tasmanian Tiger in captivity in 1936 in Hobart. The resource material (Lewis, Neal, & Gurry, 2006) was designed to help children aged 6-12 explore the issue of threatened species, covered several KLAs and included teacher's material, information sheets, an interactive CD-Rom, posters and booklets. In the program students were encouraged to consider what habitats are, how they are threatened and potential solutions to the threats. Students who explored and explained biodiversity and its threats were encouraged and rewarded, but the program rarely engaged such young students in the true complexities of the issues or relationships between economic and social choices and habit loss. The program did encourage students to challenge and seek to change the systems that exploit biodiversity.

At the heart of systems approaches is the idea of learning to influence for change. Change requires more than merely understanding the problem and articulating it effectively and persuasively to others. Influencing change requires a deep understanding of how systems work and how change within systems can occur. In schools, this takes the form of students being taught and assessed on how clearly and persuasively they are able to communicate environmental issues to stakeholders. It can be argued that in reality environmental problems are more often solved by stakeholders influencing the system, than by the individual actions of stakeholders. As future stakeholders, the process of students developing knowledge of environmental problems; understanding the systems that have created these problems; and thinking about how to influence the systems in order for the problems to be addressed must be considered to have validity as an ESD approach.

In conclusion, systems thinking challenges students to shift their perceptions, and to consider different ways to organise society: from parts to the whole, from objects to relationships, from objective to contextual knowledge, from quantity to quality, from structure to process, from contents to patterns (Foundation for Environmental Education,

2008). For teachers, systems thinking affords an opportunity to integrate sustainability into the total curriculum, while still meetings the demands of state syllabuses and curriculum frameworks.

3.1.10 Values Clarification and Issues Analysis

> Education must deal with values and views. Clarifying and classifying these teaches people to think ahead and plan their future, and to carefully consider the implications as well as the consequences of their behaviour on themselves and others.
>
> UNESCO (2002, p. 24).

> ESD is fundamentally about values, with respect at the centre: respect for others, including those of present and future generations, for difference and diversity, for the environment, for the resources of the planet we inhabit.
>
> UNESCO (2004, p. 4).

A key part of what teachers aim to foster in their students is the development of strong positive values in order to help 'round out' their character. We hope they will become active and responsible citizens, with a love of lifelong learning; that they will realise their strengths and discover their potential. As such, education has never been a values-free zone. Such personal development is also likely to foster the values that underpin sustainable development, but ESD aims not just for a well-rounded character, but rather a student who becomes an active participant in change.

Dealing with controversial issues in a balanced and sensitive manner is one of the greatest challenges teachers face. *Values clarification* is an educational approach that employs a variety of strategies where learners critically examine and clarify their own values, particularly those that are unarticulated and unconscious. The process helps to uncover the ways that culture, gender and socio-economic background shapes one's deepest values. Learners who are aware and critical of cultural perceptions and the process of global consumerism can develop an understanding of how some aspects of an

homogenised global consumer culture can lead us more rapidly to unsustainability whilst others can help improve quality of life. In this way, values clarification can help educators to help overcome the tendency to reduce complex situations to simple polar opposite positions, as so often occurs with complex issues.

Cutter (2001) has outlined how technological perspectives of sustainable development have a tendency to promote the view that the operation of free market economic forces, combined with advances in technology will be sufficient to remedy the effects of any environmental crisis. Ecological perspectives of sustainable development, on the other hand, propose more fundamental, transformative cultural changes. Lowe (2002) has argued that it is "morally indefensible" to continue to put the dominance of market forces and the present generation of consumers above the needs of all other species and all future generations. Thus, any consideration of environmental issues "leads inevitably into a complex discussion of social, economic and moral issues" and that any "serious quest for the goal of environmental literacy needs to be based on this broader understanding" (p. 7). The fact that there is no preferred sustainable development model further muddies the waters for educators attempting to implement ESD, however, genuine engagement with sustainability requires us to understand how these factors shape our values and thus our view of the world.

Tilbury (2004b) has outlined how many environmental educators argue that in order to achieve sustainability critical reflective models are needed in order to help learners reflect upon their own cultural lens that has shaped their worldviews. Despite the importance of values clarification to ESD, documented examples of it being used to address sustainable consumption issues in Australian schools are rare.

In 1993 WWF UK commissioned Williams and Huckle to develop a significant EE program, the *Global Environmental Education Programme,* (previously referred to in Section 3.1.6) which included a multidisciplinary curriculum development teaching pack for secondary students investigating environmental and sustainability issues through critical reflective questioning. Dealing with issues such as advertising and nature, influencing decision-making and understanding cultural lenses, the program aimed to develop in students a deep understanding of how the world works.

Values clarification is similar to the technique of *issue analysis*, which is a structured technique for exploring the environmental, social, economic, and political roots of problems faced by communities. Issues analysis helps students to identify major arguments related to a community problem; the perspectives and goals of the key stakeholders and assumptions related to that problem. The process also looks critically at the proposed solutions and takes a triple bottom line approach to examining the costs. Issue analysis can be done briefly or in depth, and is and interdisciplinary approach that can be used with any environmental, social or economic problem.

3.2 Teacher Training in Environmental Education

> If sustainable development education is to have a sustainable future, teachers must not only convinced of the need for ESD but also be equipped with strategies for integrating it into their classroom practice.
>
> UNESCO (2005a, p. 24)

There are millions of teachers in the world, all of whom need to be trained to address Education for Sustainable Development. This is an immense task; however, the faculties of teacher education institutions have the potential to bring about tremendous change. Such institutions develop teacher education curricula, train new teachers, provide professional development for practising teachers, and consult with those responsible for curriculum design, implantation and policy setting. These touch points are where the systemic change that can promote EDS will occur.

As early as 1977, the *Tbilisi Declaration* proposed that EE become an obligatory part of initial and ongoing teacher education. The uptake of EE into schools was initially a slow and ad hoc process, with little in the way of policy or curriculum support. Over the years UNESCO has repeatedly called for the reorientation of teacher education to reflect the paradigm shifts needed to bring about effective ESD. The second half of the 1990s saw a steady growth in the quality, extent and integration of ESD into schools but in 1990, UNESCO-UNEP still identified teacher education as the “priority of priorities” to

improve the effectiveness of ESD. In 2000, UNESCO established the UNITWIN/ UNESCO *Chair for Reorienting Teacher Education to Address Sustainability* to globally target teacher education institutions as key agents of change towards sustainability, because "to effectively and completely reorient education to address sustainability, all disciplines in a teacher preparation institution can and should be involved in the reorientation process" (Hopkins & McKeown, 2001, p. 8).

Nonetheless, teacher education in Australia continues to be underpinned by expert-led, instructive teaching methods and a fragmented curriculum, which are inconsistent with the Learning for Sustainability paradigm. McKeown-Ice's survey (2000) of formal teacher training programs for evidence of ESD training found that, in general, students had limited access to EE content and methods. Several years later Collier and Smith (2007), felt that teacher-training institutions were still lagging behind in approaches to whole school sustainability, and that this will be part of "the next stage in the evolution of EE in the school sector" (p. 5). Indeed, the *Melbourne Declaration* and National Partnership on Improving Teacher Quality provided the impetus for the 2011 *National Professional Standards for Teachers*, which were released by the Australian Institute for Teaching and School Leadership (AITSL, 2011). The AITSL National Standards are grounded in the principle that teachers have a "direct impact upon student achievement" (AITSL, 2011, p. 1).

The AITSL *National Professional Standards for Teachers* consist of seven standards at the Graduate Teacher stage, none of which explicitly address ESD themes. The focus appears to be on knowledge and skills. Australian graduate teachers are expected to display competence in human diversity and "demonstrate knowledge of teaching strategies that are responsive to the learning strengths and needs of students from diverse linguistic, cultural, religious and socioeconomic backgrounds" (AITSL, 2011, p. 8). This is rather vague, and Kirby and Crawford (2012) found that "teacher program standards to date in Australia are not explicit regarding the ways in which new teachers must be trained in order help their own students "compete in the global economy on knowledge and innovation" (MCEETYA, 2008, p. 4)" (p. 20), and concluded there is a

“disconnect between what governments and accrediting bodies are seeking in beginning teachers and the work that goes on in teacher training in these institutions” (p. 21).

When launching the Decade of Education for Sustainable Development (DESD), UNESCO (2005a) called for ESD to not be added as another subject in the timetable but to be treated as “an organising principle and cross-cutting theme” (p. 24). However LfS/ESD is not mandatory for prospective teachers engaging in initial teacher education, nor is there an interdisciplinary or whole-school approach. At present only a limited number of teacher education institutions offer ESD courses to prospective teachers, usually as an elective unit or as a small component of a core unit in Education degrees. Trainee teachers of Human Society and its Impact on the Environment (HSIE) and Science teachers may fare a little better, but courses for secondary teachers tend to reflect the subject boundaries found within the school curriculum and the discipline divides found within university faculties, making interdisciplinary approaches difficult. A further difficulty is that instruction would need to be comprised of not only science, but also social, political and economic concepts (Powers, 2004). Thus there continues to be a lack of understanding amongst teachers of the interconnectedness of issues of the environment, society, economy and politics and its implications for ESD.

In fact no initial teacher education courses (Gough, 2004, cited in Tilbury, et al. , 2005) in Australia, and only some post-graduate courses, make explicit reference to approaches such as learning for sustainability (Fien, 1995), education for sustainability, sustainability education (Gould League, 2012), or the socially critical pedagogy (Fien & Tilbury, 1996) associated with the new paradigm.

Additionally, prospective teachers have to cover an increasingly diverse curriculum that incorporates issues such as student-behaviour management, quasi-legal issues, and equity and citizenship themes. ESD could seem to be just one more area to squeeze into an already overcrowded program. ESD is generally not viewed as a priority and teachers are generally inadequately prepared to effectively achieve its goals in the classroom.

It might be supposed that primary teacher education courses offer more opportunities for ESD cross-curricular learning. However, teacher education in this area tends to rely on departments such as environmental science or geography stepping in to teach prospective teachers about environmental concerns. These units or courses may develop teachers' environmental literacy, but they are not tailored specifically to develop the knowledge and skills required, and certainly do not develop the whole-school approaches to ESD that would take it beyond the school curriculum. Thus, when entering schools few teachers have competencies in LfS/ESD.

Recently, a handful of Australian Universities have been offering elective units and/or external units in EE and ESD that address both content and methodologies. For example, Macquarie and Griffith Universities offer *Master of Environmental Education and Master of Environment,* respectively, while Deakin and Macquarie Universities offer units on *Trends and Issues in Environmental Education* and *Education for Sustainable Development,* respectively.

Students who enrol in these courses include school teachers and staff from EE centres and community or industry-based environmental educators. The post-graduate qualifications offered by these universities deal more holistically with ESD content and pedagogy; however they are not tailored specifically to school curricula. Teachers must make the links themselves between the knowledge and skills they are acquiring and their classroom practice and programing. The problem remains that teachers must decide to undertake such post-graduate education *themselves* and it remains unrealistic to expect large numbers of practicing teachers to undertake such courses.

Meanwhile practising teachers have limited opportunities to engage in comprehensive professional education or development courses in EE. As with initial teacher training, in-service professional development programs are highly competitive as teachers strive to keep up-to-date with emerging issues and shifts in educational theory and practice. ESD is forced to compete with more high profile programs in the areas of information and communication technology and literacy.

There have been a handful of school-based ESD programs run by education groups, state agencies and NGOs, which have included professional development workshops to assist specifically with the implementation of their programs in schools. The *Sustainable Schools Program* (n.d.) and the *Waste Wise Schools Program* (n.d.), for example, provided training opportunities for teachers in EE. While professional development programs such as these are a step in the right direction, the risk is that they may tend to develop teachers' knowledge and skills surrounding a specific issue of concern, such as waste or water, and only develop teacher competencies in implementing that specific program.

Where they do exist, professional development courses for teachers in ESD have been ad hoc and often lacked focus. This, coupled with limited opportunities for ESD in initial teacher education, has meant that very few teachers have had any professional development in LfS/ESD. State and Territory education departments do not currently require their teachers to have education or professional development in ESD, although Victoria's EE policy does recognise the need for professional development of teachers to offer effective ESD in schools.

The Australian Government Department of the Environment and Heritage's 2000 National Action Plan; *Environmental Education for a Sustainable Future* identified "more professional development opportunities for teachers in the formal education sector" (p. 5) as a key area of need in EE. The establishment of a fellowship program for teachers to assist with their professional development needs was proposed in the plan.

The 2009 update, *Living Sustainably: the Australian Government's National Action Plan for Education for Sustainability* continued this theme by stating that "this work will include professional development for teachers, greater access to quality teaching and learning resources, developing policy frameworks and practical support for changes to campus management" (p. 21) and that the "Australian Government will work with state and territory governments to provide in-service professional development for teachers in

education for sustainability, including developing teaching resources" (p. 24). Despite these repeated assertions, such 'vision statements' seem to remain largely unrealised.

In Australia, only one policy document has been produced which contains EE standards for teachers. In 1993 the Queensland Board of Teacher Registration published EE core competencies for teachers. While the initiative was well received by environmental educators, both Cutter-Mackenzie and Smith (2001) and Spork (1992) felt the competencies (which were not mandated) were too broad to effectively implement and therefore had little impact on the EE practices and the wider teaching profession.

The work of Robottom (1987a, b) has been very influential in the field of EE. He suggested that teachers and teacher educators should be encouraged through professional development to critically question the relationship between theory, practice and circumstances, rather than continuing to follow traditional technocratic and often unquestioning approaches. He constructed five pedagogical principles for teacher education practice, as EE is:

- *Participatory and practice-based* and knowledge is constructed through experience, dialogue and reflection;
- *Enquiry-based,* and so teachers should adopt a research approach to curriculum planning and teaching skills;
- Served by an *ideological critique* of values and assumptions, enabling teachers to reflect upon their practices, empowering them to create changes in accordance with the EE objectives they favour;
- *Community-based* and involves students in the active investigation and involvement with issues of sustainability;
- *Collaborative* and build teachers' abilities to influence the development of transformative practices in EE.

To this end, he recommended *action research* as a suitable methodology to bridge the gap between theory and practice in EE. In action research, theory is not separated from practice, as the teacher is both researcher and practitioner. Action research can assist in

the professional development of teachers by enabling them to understand and challenge the reasons for their actions, and the institutional structures and relationships that create them. This is important if teacher education is to reorient structures and practice towards ESD.

Fien (2001b) agrees that action research is congruent with learning for sustainability principles, and that "active participation and critical reflection are essential components of professional development [in EE] (p. 79)." Internationally, programs such as the 2001 OECD's *Environment and Schools Initiative* (ENSI) and the 1996 UNESCO Griffith University project *Learning for Sustainable Environment Project* (Fein, 2001b) have used action research for teacher training and the development of teacher understanding and skills in EE.

Huckle (1996) has outlined the *critical pedagogical* approach to EE, which is significantly different to traditional teaching styles. By using a process of communicative action based on shared understanding and democratic dialogue, teachers have the potential to become transformative thinkers, capable of influencing the development of curricula and pedagogy. Huckle feels that "teachers should learn through critical pedagogy in universities, school classrooms and the community and should thereby develop skills in planning and delivering a wide range of experiential and democratic teacher and learning activities of the type now used in moral, social, developmental and Environmental Education" (p. 109).

If teacher education programs were to change and be underpinned by this paradigm teachers would be introduced, not only to a systemic view of economy, environment and education, but their experiential, interpretive and critical knowledge would also be developed. Such a fundamental shift in approach would result in curricula that are socially useful and empowering. Unquestionably, most experienced educators are untrained in such a system view and it therefore needs to not only be part of the teacher education curriculum, but also of professional development packages and resources.

Internationally, there have been some successful programs designed to shift forward teacher training and professional development. The Organisation for Economic and Cooperative Development-Centre for Educational Research and Innovation's (OECD-CERI) *Environment and Schools Initiative* (ENSI) is an example of a successful professional development program for teachers. The initiative, based on a cognitive construct model, is targeted at schools across Europe and Australia and aims to develop both the environmental awareness of students, and qualities such as initiative, interdependence, commitment and readiness to accept responsibility.

The cognitive construct assumes that competency is about potential; rather than behaviour. In it, cognitive abilities are coordinated with management and action qualities. In other words, this approach asks teachers to adapt what they have learned in a controlled environment to their practice, finding innovative solutions to their problems and engaging in critical reflection. Thus competencies are used to enhance cognitive structures, are underpinned by a process-oriented approach, and positive and innovative change is seen as a successful validation of competency.

The action research component of the ENSI is innovative as it engages and supports teachers in evaluating their work with students, and in communicating and contributing to professional knowledge while bridging the gap between EE theory and practice. Research (Kyburz-Graber & Robottom, 1999) has shown that the impact of the ENSI projects has led to a shift within schools to student-teacher relationships that are more democratic, while also being instrumental in developing intra- and trans-national partnerships and whole-school approaches to EE innovation.

In 2000, the North American Association for Environmental Education (NAAEE) developed a standards project with a focus on developing EE materials, non-formal programs, professional development of environmental educators, and a trainer's bureau. In particular, *The Preparation and Professional Development of Environmental Educators Guidelines* encapsulated broad statements about the basic knowledge and abilities educators would need in order to provide high quality EE. The guidelines took a developmental approach with the broad goal of improving the knowledge and practice

of environmental educators in both formal and informal educational settings. This caused some debate, with Wals and van der Leij (1997), for example, arguing that "defining and standardizing environmental education …becomes problematic and undesirable" if it requires "universal goals and objectives that would be imposed upon schools and communities regardless of the contextual realities that challenge them" (p. 54) and that although "there is merit in being exposed to a wide variety of points of view and ways of thinking" they argue "*against* the notion of national standards and *in favour of* emphasizing non-behaviouristic approaches" (1997, p. 55).

In Australia, the Australian Association for Environmental Education (AAEE) aims to meet the professional development needs of environmental educators through its three major roles:

- to promote the most extensive and effective use of education to help people to live more sustainably;
- to support members and others in the sector via professional development; and
- to develop local networks which facilitate the sharing of programs and skills.

The Australian Journal of Environmental Education is produced in order to present information and argument which will stimulate debate about educational strategies that enhance the kinds of awareness, understanding and actions that promote environmental and social justice.

Fien and Tilbury reviewed the research on the provision of EE within teacher education in 1996 and found that in the years since the 1977 Tbilisi Conference "not much has changed" (p. 38). A decade later there were still no teacher standards in EE in Australia (Cutter-Mackenzie, 2005). In Australia, 250,000 teachers are responsible for the education of 3.5 million students, yet, despite the worthy teacher education goals set out in international agreements, such goals are yet to be effectively recognised in national education policy and thus in teacher training. This dearth of teacher education programs in ESD has resulted in a lack of competence amongst teachers to effectively teach LfS/ESD in schools. Teacher training in ESD matters because it is educators who have

the capacity to influence the attitudes, knowledge and skills of students and to ultimately increase the nature and quality of sustainable behaviours and practices beyond the classroom.

3.3 Implementing Education for Sustainable Development

> The values and ethics surrounding environmental protection must continue to be addressed through education, so that environmental understanding and participation becomes automatic in our lives. Without this, the focus of environmental management will tend to be on repairs and temporary fixes, rather than longer term solutions.
>
> Robert Hill, Minister for the Environment and Heritage in Environmental Education for a Sustainable Future: National Action Plan (2000, p. 1)

> We have been making people aware of the environment for 16 years or more. It is now time to examine how we can do something about it.
>
> Smith (2004, p. 2)

With the exception of NSW, Environmental Education remains a non-mandatory component of schools and continues to struggle for acceptance within mainstream curricula in Australia. Across the States and Territories, curriculum policy and guidelines documents have been slow to react to sustainability issues and it is only in the last few years that the concepts associated with it have begun to find their way into policies and programs. For most teachers and school managers, EE remains a low priority.

The reasons are many. One dilemma for formal education systems is that teaching EE as a separate subject by itself is no longer enough, and specialist discipline-based knowledge, although critical, will not lead to the holistic appreciation of the context of environmental problems that is essential. A much stronger re-orientation of all relevant

areas of formal education toward issues of Education for Sustainable Development is required.

In addition, ESD must link in with other environmental management tools in the wider community, such as regulation and enforcement, and financial incentives and disincentives. It is asking a lot of the education sector to carry the responsibility of developing in the community a fundamental acceptance that the nation's environmental objectives should be accorded equal priority with social and economic goals. Collier and Smith (2007) have discussed the criticisms that ESD, with its major focus on schools, is targeting the wrong people, making its impact 'too soft and fluffy' and too difficult to prove that behavioural change has occurred. School students, after all, are not in control of household purse strings, and are not running businesses or developing policy. Effective actions are, after all, the yardstick by which our efforts in ESD are ultimately measured.

Progress has been made, however, and in NSW over the last 30 years there has been a clear shift from single teachers in random schools teaching EE with very little support in the way of resources, to mandatory curriculum statements and a supported EE Policy for Schools with an emphasis on ESD. In the next section, the implementation of successful integration of ESD into schools is examined.

3.3.1 Sustainable Schools

> You can't have a sustainable school in an unsustainable community. You won't have an unsustainable school in a sustainable community. You can't have a sustainable school in an unsustainable school system. You won't have an unsustainable school in a sustainable school system.

Phil Smith, Education Manager: NSW Department of Environment and Conservation (2005) cited in Tilbury and Ross (2006)

There are two shifts taking place concurrently in schools; one working towards LfS, and another promoting an approach to school management that encourages teachers and

students to adopt more sustainable practices. Ideally, these processes are integrated and work in tandem with each other, as the hidden curricula of schools convey the values that are important to the school, and should not contradict the lessons of the classroom. For example, the food sold in a school canteen and the packaging it comes in speaks as loudly to students as any formal classroom lessons on nutrition and waste. These two approaches must work together if they are to deliver a *Sustainable School*.

The key principles of Sustainable Schools came partly from the *Brundtland Report* (also known as *Our Common Future*) of the World Commission on the Environment and Development (1987), which promoted the principles of maintaining biodiversity, the precautionary principle, intergenerational equity and environmental cost accounting.

In Australia, there has been a history of educators exploring ways to improve the school buildings and grounds in order to improve the natural environment of the school and to provide EE learning opportunities. In 1975, *Bringing School Grounds Alive* was written for the South Australian Education Department and subsequently became available nationally. The *Flora for Fauna Project* (now known as *Wildscape*) was a web-based resource, developed in 2001 by the Gould League for Australian teachers that provided resources and information to assist students in developing plans for wildlife habitats in their school grounds. Funding programs, such as the NSW Government Environmental Trust *EcoSchools Grants,* have led to some schools re-designing their grounds to include features such as outdoor classrooms, and native, bush-tucker or community vegetable gardens.

In 1998, the *Eco-schools Program* in NSW provided support and resources to schools to develop *Learnscapes* within their school grounds. *Learnscapes* (established by the non-profit organization Hands on Learnscapes Inc) is similar to the international OECD CERI ENSI program *Learnscapes Across The Globe*, and is a collaborative, dynamic and context specific project, that links the curricula to the grounds of the school and is designed to allow students to interact with an environment, which may be natural or built, interior or exterior and located in schools, near schools or beyond. Originally starting with just three schools in NSW, the program has now assisted more than 300

schools in Queensland, NSW, ACT and Victoria. This program has resulted in a number of outcomes including increased flora and fauna biodiversity in school grounds through tree planting and the creation of native gardens, the rehabilitation of local environments, the design of unique and energy efficient buildings, including outdoor classrooms and the creation of community vegetable gardens.

Programs to modify school grounds as EE learning environments are also popular overseas. Such programs include *Learnscapes Across The Globe*, an OECD CERI ENSI International program; the UK's *Learning through Landscapes*; *The Boston Schoolyard Initiative* (USA); Canada's *Learning Grounds* programs; and New Zealand's *Enviroschools Programme*.

Research by Lucas (1997a, b) suggests that the design, features, size, utilisation and management of school grounds can impact upon the life and work of the school and on the quality of education provided. Lucas suggests that designing and managing school buildings and grounds based on the principals of the United Kingdom's *Learnscapes* can lead to improvements in relationships between teachers, students and parents, an enhanced image of the school within the community and a reduction in the incidents of bullying, accidents and vandalism, as well as more effective teaching and learning and more efficient use of resources.

In NSW, the *Environmental education policy for schools* (2001) states that:

Schools will:

- manage school grounds in accordance with the principles of ecologically sustainable development;
- develop school grounds as part of the overall school plan; and
- identify learning opportunities for students resulting from the management of school grounds. (p. 11).

The policy emphasises the need to educate for sustainability and was developed to ensure long- term engagement by schools in their management of the environment and their teaching and learning about sustainability. The policy states that "school environmental planning concurs with trends in industry and government where environmental management systems (EMS) are increasingly being introduced in accordance with the International Standard ISO14001" (Sustainable Schools NSW, p. 1). ISO 14401 is an international standard that accredits organisations for successfully undertaking set processes that lead to the adoption of sustainable practices.

In NSW, the current administrative requirements set down by the Department of Education and Training Schools require all government schools to develop a *Whole School Plan*. Schools must also develop *School Environmental Management Plans* (SEMPs) as a part of this wider administration requirement. A SEMP is a tool to help schools plan and coordinate ESD, by assisting in the achievement of objectives in the three focus areas of curriculum, management of resources, and management of school grounds. All government schools must develop a SEMP around the three focus areas that works to a schedule and is implemented in stages. The SEMP must be able to be incorporated into the *Whole School Plan*, and link school administration and management with curriculum plans. In this way schools, like any organisation, are asked to take a holistic approach to their planning and to look at the big picture, thus ensuring management and teaching practices are not separated.

Around the same time as this policy was introduced, the NSW Government's three-year EE plan, *Learning for Sustainability (2002 - 2005)* began, marking the end of more ad hoc leadership in this area. The *Sustainable Schools Program* (SSP) was also introduced. The program first developed in isolation of the formal theory of ESD but more recently it has begun to incorporate much of its criteria. Sustainable Schools now acts to facilitate the development, implementation and review of SEMPs in order to encourage a shift through such plans towards more sustainable practices,

Between 2003-2004 *Sustainable Schools* was funded and managed in NSW through a partnership between the Department of Education and Training (DET) and the

Department of Environment and Conservation (DEC). A two-year pilot program was conducted in 198 schools across the state. Twenty-two part-time Sustainable Schools support teachers, mainly based in Environmental Education Centres, were employed. The SSP put the key principles and processes of the *Learning for Sustainability* plan into practice by beginning to establish structures to enable all government agencies and organisations with an interest in school EE to deliver more targeted, effective and coherent educational initiatives.

The *Sustainable Schools Program* in NSW aims to:

- commit all government departments to an integrated approach to EE, and to helping schools adopt sustainability practices;
- involve school communities in developing, implementing, monitoring, and reviewing their SEMP so that schools can learn more about how to adopt more sustainable practices;
- develop curriculum, policies and practices to assist schools to achieve more sustainable practices, such as more sustainable purchasing practices by the administration staff;
- develop and enhance the support networks among local councils, schools, and businesses that might support the school community; and
- help school communities develop their knowledge, skills and confidence in auditing, reducing waste, energy, water use and pollution and understanding and implementing the key principles of sustainability in schools.

Sustainable Schools is also a systems-based program with targeted activities for the range of key components that are part of the whole school system. In this approach, administrative practices are linked with curriculum and teaching and learning practices. The program also aims to assist schools in constructing a realistic and inclusive planning framework, enabling them to move beyond rhetoric to develop partnerships between schools and their communities. In this way, Sustainable Schools is a program that looks

beyond the school grounds and carries a sustainability agenda to two main target areas: the school itself and the broader community.

The sustainable design and management of school grounds is a key feature of the SSP. When implementing the program, schools assessed the grounds in preparation for planning and implementing the SEMP. Schools are encouraged to consider how schools' grounds could be used as a tool for curriculum learning and how they can engage stakeholders in partnerships throughout the process. As a result, schools can save a considerable amount of money in waste disposal, reduced cleaning costs, and water and energy bills. They can also improve the image and appearance of the school, while developing amongst students a feeling of personal control and empowerment. In addition, students have opportunities to work on real-world problems and learning outcomes across many KLAs, such as Mathematics, Science and Human Society and its Environment, by using real-life contexts that help students engage with real issues and change.

There are clear links to the curriculum contained within the Sustainable Schools model; however they are limited to the four areas of energy, water, waste and biodiversity rather than the 15 strategic perspectives of the DESD agenda. Henderson and Tilbury (2004) have also noted that the socio-cultural dimensions of LfS do not appear as prominent components in whole school programs such as Sustainable Schools. Skamp and Bergmann (2001) feel that within mainstream school education many schools have only just begun to explore the potential of sustainability learning opportunities provided through the school buildings and grounds.

Nonetheless, it is evident that for some sectors of society, including schools, the principles of ESD are rapidly becoming a consideration in the design of new programs, whether consciously, intentionally and explicitly or simply implicitly as a logical but unintentional decision. The NSW SSP has provided an excellent model for demonstrating key ESD components including the:

- development of a collaborative working environment and a cooperative vision;

- development of a framework supporting futures thinking and values clarification;
- development of skills in systemic thinking;
- establishment of embedded change;
- establishment of long-term partnerships;
- participation of various groups; and
- provision of opportunities for capacity building within the groups involved.

In NSW however, the basic problem remains in the design of the curriculum framework offered by the Board of Studies and the mandatory nature of the Key Learning Area (KLA) model that NSW schools have to follow. A KLA model does not readily support the holistic approach to curriculum needed to implement LfS/ESD. This remains especially true for secondary schools where subject faculties still specialise in specific sub-sections of the total curriculum, with no whole-school overview. Although good programs and support for LfS/ESD exist, state education departments have few funds to augment the programs themselves. A further problem is that teachers may see requirements for ESD planning and programs as yet another task inflicted on them, rather than seeing it as a process that can be integrated into the work they are already doing. While this negative impression lasts the problem is likely to persist in many schools. Nonetheless, many schools have been able to begin the implementation of LfS/ESD principles into schools, especially through the use of partnerships.

3.3.2 Partnerships

> In the past leadership was focused on the need to go out into the world with answers – to be the 'expert' and protect the expert position. In the midst of social, economic, political and environmental complexity and uncertainty, we need to have the courage to go out into communities with questions and to propose some solutions. We need to acquire many of our solutions from stakeholders themselves. They know what is possible and what messages will work.
>
> Collier and Smith (2007, p. 7)

> The challenge of sustainable development is a difficult and complex one, requiring new partnerships – among governments, academic and scientific communities, teachers, nongovernmental organizations (NGO's), local communities and the media. All are essential to the birth of a culture of sustainability.
>
> UNESCO (2002, p. 5)

A core element of pedagogical approaches that contribute to ESD is the concept of participation. There is a call to move from action elements of the curriculum to a participatory approach. There are many elements associated with such an approach including sharing, listening, equality, reflection, co-learning, negotiation, cooperation, collaboration, trust, futures-orientation, democracy and critical thinking. Reorienting school education in this way will require strong and consistent leadership from governments.

At the state level, EE policies in both Victoria and NSW encourage schools to establish partnerships with a variety of stakeholders in order to help protect the environment. These polices, however, do not indicate what types of partnerships are needed, or indeed how they should be formed. Uzell (1999) identified four models of possible relationships between schools and their local communities.

In the first model, the school can be viewed as an island where all learning is confined to the classroom, isolated and with little or no contact with the community. In the second model, the barriers are partially opened and the community is invited into the school. In the third model, the school becomes a guest in the local community where students take what they have explored in theory in the classroom and attempt to work on and influence those conditions. Finally, Uzell describes the school as a social agent, actively dealing with environmental problems. Action-oriented education occurs outside the school, but within the local community, in school time. Some actions are direct (e.g., waste management) and others indirect (e.g., influencing others - parents, politicians and planners). A number of schools in the Sustainable Schools pilot were able to achieve a

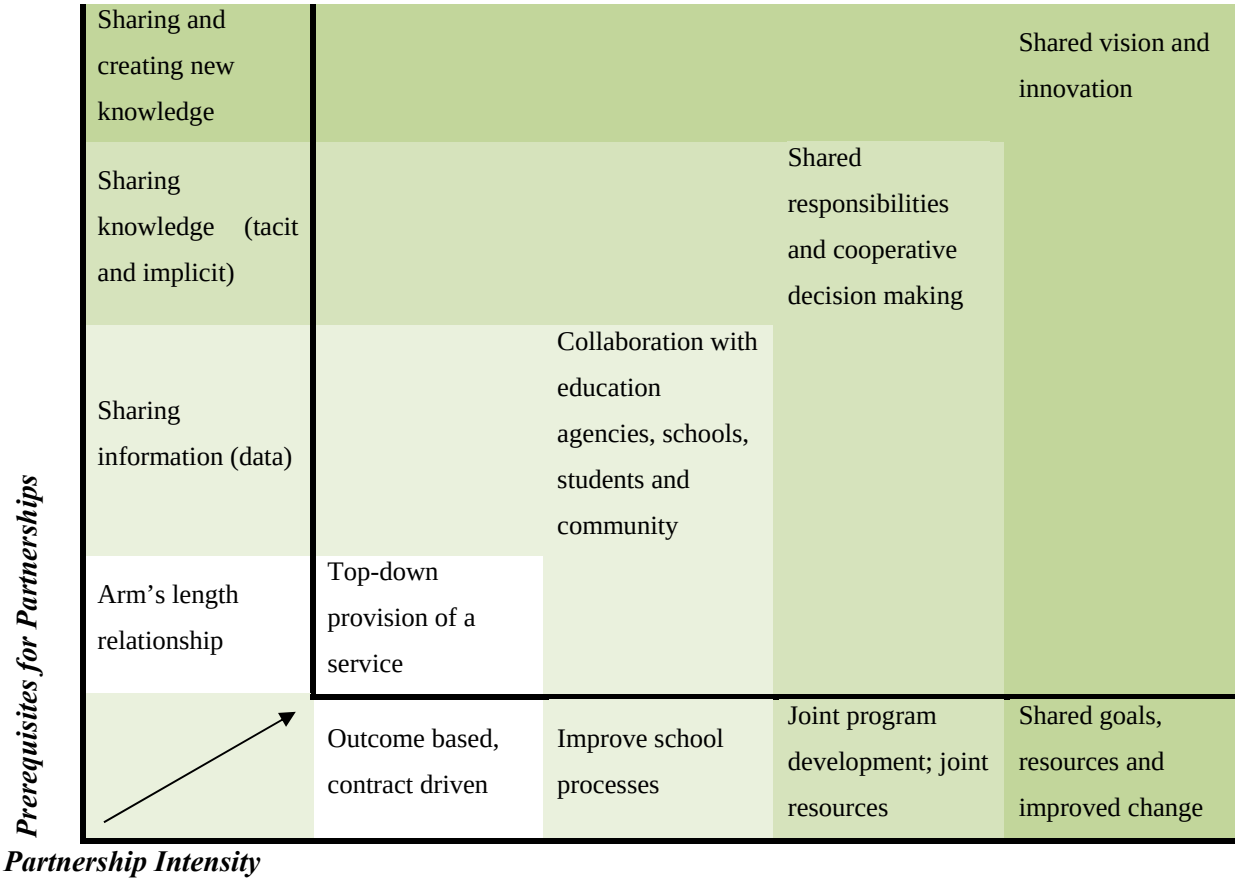
situation similar to Uzell's fourth model but for many it was still an issue to be grappled with and an ideal to be aimed for (Smith, 2006).

The idea cross-sectoral and multi-stakeholder partnerships features strongly in the literature as being critical to sustainability, so it is not surprising that calls for partnerships also feature strongly within sustainability strategies, policies, guidelines and programs internationally. For example, the Canadian *Framework for Environmental Learning and Sustainability* calls for support to be provided for "the creation of partnerships between and among educators, governments, NGO's, institutions and private sector" (Government of Canada, 2002, p. 6) and England's *Sustainable Development Action Plan for Education and Skills* (2003) reiterates this message, specifically identifying the role of key stakeholders and partners in assisting schools achieve sustainability.

The desirability of partnerships is also well documented in the authoritative literature arising out of the Rio and Johannesburg Summits. One of the Guiding Principles of the *Johannesburg Plan of Implementation* is to "enhance partnerships between governmental and non-governmental sectors, including all major groups, as well as, volunteer groups, on programmes and activities for the achievement of sustainable development at all levels" (United Nations, 2002a, p. 7). At its 2004 AGM the OECD *Environment and Schools Initiative* (ENSI) undertook a strategic planning process to map out a focus for the next five years. The new strategic plan shifted the OECD ENSI's EE priorities towards research into community-school partnerships and was interpreted as a critical shift for schools wanting to engage with sustainability. The *United Nations Decade in Education for Sustainable Development* (2005-2014) locates partnerships at the core of its implementation plan.

The literature in Australia also talks of the establishment of partnerships as crucial in LfS/ESD initiatives. Tilbury (2004a) says, "partnerships, which share learning experiences, can accelerate the process of change towards sustainable development" (p. 4), while Eames and Bolstad define partnerships as "a complex and multidimensional

form of relationship that goes beyond simple linking and networking between different parties and stakeholders in education" (2004, p. 2).



Adapted from Prahalad and Ramaswamy (2001, p. 4)

Figure 3.1 Partnerships continuum for improved EE in schools

There have been a variety of environmental initiatives involving schools in partnerships. These included the *School Communities Recycling All Paper* (SCRAP) program (n.d.) where schools collected waste paper in return for reams of recycled paper. Starting with just eight schools in 1991, SCRAP grew quickly, and by 2003 SCRAPs membership had reached around 1500 active, recycling educational bodies including schools (around half the schools in NSW and the ACT), colleges, child care centres, universities and over 1000 other non-profit and government bodies and businesses. After 15 years it was no longer viable to collect scrap paper for recycling this way, but the company survives, and provides environmental goods and services to schools and other organisations.

OzGreen was formed in 1992, and now operates nationally across Australia and internationally in India, East Timor, Papua New Guinea and Pakistan. OzGreen is a provider of sustainability learning and leadership programs that use action research to implement the *Sustainability in Action Process*, bringing together in partnership sustainability education, leadership development and connectivity or network building. Participants develop and implement sustainability action and sustainability change leadership plans.

In Victoria, the Gould League and the Victorian Department of Education and Training have broadened their Waste Wise Schools Program. The program is licensed in three states, funded by EcoRecycle Victoria, and managed in consultation with the Gould League. It includes a one-day professional development workshop for teachers on matters relating to waste reduction and management issues for schools. The program is an action-based, real-life program where the results of the students' efforts are clearly visible, and therefore student learning becomes much more purposeful. As schools work to reduce their water usage, divert waste from landfill and recycle materials, teachers have opportunities to introduce hands-on maths and science activities and for improving literacy and presentation skills. There are economic benefits to schools in reduced water usage, reuse and recycling opportunities, for example, the sale of aluminium cans or worm farm fertiliser. Cutter-Mackenzie (2010) reported that 40 percent of Victorian schools have participated in Waste Wise Schools and that 1,502 teachers have been trained in free workshops. Surveys of parents show that the Waste Wise Schools Program is changing the behaviour and thinking of families towards waste and litter reduction and recycling practices, and typically the program influences 50 to 60 percent of parents.

In 2001, the *Stephanie Alexander Kitchen Garden Program* (n.d.) was piloted at Collingwood College, Melbourne and in 2004 the *Stephanie Alexander Kitchen Garden Foundation* was established in response to its success. The Foundation now works with government and partners in 267 primary schools across all states and territories of

Australia to ensure the provision of effective, experience-based kitchen garden programs.

The EE/ESD sector has acknowledged the importance of partnerships and is quickly learning how to engage in cross-sectoral and multi-stakeholder partnerships in ESD strategic frameworks. The latest trends indicate that the sustainability agenda is influencing EE towards *multi-stakeholder* partnerships for change, based on a common vision, shared decision-making, participation, ownership and commitment amongst stakeholders. Some progress has been made in developing such educational initiatives, but much remains to be done.

3.3.3 Australian Sustainable Schools Initiative (AuSSI)

This is a successful example of how a partnership between the Australian Government, the states and territories can lead to systemic change. The initiative entails a whole-of-school, action learning approach to sustainability which is generating measurable social, educational, financial and environmental outcomes.

Department of Environment, Water, Heritage and the Arts (2010, p. 13)

Another initiative, the *Sustainable School Program* (SSP), tried to link pre-existing fragmented EE programs (such as Landcare, Energy Smart Schools, Waterwatch, Waste Wise and Waterwise) into a more integrated program via the *Australian Sustainable Schools Initiative* (AuSSI). The SSP challenged schools to shift their current views on the role of education and schooling by locating the school within the social system and the learner within the system of the school. The SSP placed partnerships at the core of its program design. The NSW program involved a Joint Agency Support Group - a partnership between the NSW Department of Education and Training, the NSW Department of Environment and Conservation and other government departments with an environmental brief.

Beginning with a pilot program in 350 schools in NSW and Victoria in 2002-2004, the program successfully demonstrated how to support a whole of school approach to EE via

new partnerships formed between State and Commonwealth government education and environmental agencies, industry, local government, NGOs and schools. Smith (2005) reports that "many environmental education programs in the 1990s were never officially evaluated but with the NSW Sustainable Schools pilot the evaluation was both summative and formative and undertaken by an external group. This is an excellent development and gave more credibility to the program" (cited in Smith, 2006, p. 27). Based on the success of the pilot, the national AuSSI was established and the federal government committed funding for a roll-out of Sustainable Schools across Australia.

AuSSI has aims that include:

- teaching and learning for sustainability as an integral part of school curricula and the implementation of policies and practices that support effective ESD;
- schools planning, implementing and reviewing their approach to sustainability as part of their everyday operations and using natural resources, including energy, water, waste and biodiversity, in more sustainable ways; and
- schools working towards sustainability in partnership with their local communities and with school authorities reporting on changes towards sustainability.

AuSSI now has more than 2,500 schools participating, which represents some 25 percent of schools nationally. As part of the initiative, schools implement sustainability as part of their everyday operations, focusing on the management of a school's resources and facilities, including energy, waste, water, biodiversity, landscapes, products and materials. The program is innovative in that there is a significant level of evaluation at individual school, regional and state or territory level. Participating schools have reported reductions in waste collection of up to 80 percent, water consumption of up to 60 percent and energy costs 20 percent (with associated reductions in greenhouse gas emissions) (Department of the Environment, Water, Heritage and the Arts, n.d.).

These activities can also be integrated into teaching and learning activities. The aim is that other broader social and educational benefits will follow from participation in "a

learning by doing process" (DEWHA, 2010, p. 1), as students build sustainability knowledge, critical thinking skills, values, capacity to take action and participate in decision making about environmental, social and economic development issues.

In 2010, the DEWHA commissioned an independent evaluation to examine the operational effectiveness of AuSSI. The report was generally supportive of the Australian Government's leadership of AuSSI. Although James (2006) has pointed out that although UNESCO is very clear in pointing out the difference between EE and ESD there is evidence in Australia that the "two are being conflated with (environmental) education for sustainability and non-natural resources perspectives are being overlooked" (p. 10), while word substitution in government documents is creating some degrees of confusion. She asserts that Sustainable Schools are working within an EE rather than an ESD framework.

3.4 Summary

This literature review has demonstrated that education for change towards sustainability is not a widespread practice in Australian schools. Attempts to introduce LfS/ESD into schools still tend to be focused on single actions such as waste reduction, planting trees, the improvement of school grounds, and changes to administrative practices. While laudable, these approaches are not filtering through the curriculum into classroom content. What is lacking is the deeper understanding and examination of the socio-economic and/or cultural contexts that are underlying causes of environmental issues.

Literature relating to ESD recognises that in order to achieve an improved quality of life there will need to be a move towards greater democratic participation and engagement of citizens in decision-making. As schools reflect greater forces in wider society, the sustainability agenda is challenging ESD to move away from single actions towards a focus on student participation in decision-making. Education initiatives are responding to this challenge and acknowledge the importance of moving ESD practice towards promoting democratic participation in decision making, understanding the real context of sustainability and for embedding change towards it. However, as Wilson-Hill (2010) has highlighted, there is a need to build the capacities of teachers in participatory

pedagogies so that the more widespread use of democratic participation in schools, linked to decision-making, is promoted.

The development of partnerships is a further challenge for ESD approaches in Australia. There are many factors that can inhibit partnerships between schools and external stakeholders. Eames and Bolstad have pointed out that "challenges appear to exist in many schools in realising the full potential of such partnerships" and "much negotiation, planning and power-sharing is required to establish true partnerships" (2004, p. 7). Despite government polices promoting the importance of partnerships, legislation and legal terminology can make it difficult for schools and community groups to engage in partnerships if strict contractual agreements designed for business, involving complexities of risk such as intellectual property and data management are involved.

The NSW EE plan (2002), *Learning for Sustainability* had two key outcomes that strongly encouraged the improving of partnerships for sustainability through enhanced cross-sectoral coordination of programs and the expansion of partnership and network activities between EE providers. Where goals aligned and partnerships were possible it called for improved planning and co-ordination to enhance the development of common multi-sectoral environmental priorities, goals and principles.

The importance of partnerships is also beginning to influence EE funding opportunities and grants for schools. The NSW Government *Environmental Trust EcoSchools Grants* encourages schools and communities in partnership to undertake activities that address local environmental problems. Funding priority is given to partnerships that link the students' learning to the issues in the local community. Similarly, the Australian Government's *Education for Sustainability Grants Program*, which ran from 2003 to 2009, encouraged schools to form partnerships with their local community, with the assessment criteria giving priority to applications that have partnerships as a core component of the initiatives.

It is more difficult to involve non-government organisations which would have to raise their own funds or charge for their services in order to participate, and so cross-sectoral

partnerships are more difficult to achieve, particularly where there is not a strong culture or experience of collaboration. In Australia, partnerships between schools and external stakeholders have been what could be termed 'partnerships at an arm's length' and commonly involve a sponsorship role and a service provided to schools. ESD partnerships need to move towards being reciprocal relationships that share a vision and seek innovation for sustainability.

Although, there is some preliminary anecdotal evidence to suggest that partnerships are important to shifting schools towards sustainability, the success and impact of this approach is yet to be fully evaluated. Schools that have implemented sustainable practices have managed to reduce their 'ecological footprint' in areas such as waste management, water and energy use, and improve their school grounds and learning environment through initiatives such as kitchen gardens and increased biodiversity. Thus, the environmental and sustainability practices of the schools involved in this study were measured in order to investigate the links between these activities and development of environmental literacy in students.

CHAPTER 4

DEFINING & MEASURING ENVIRONMENTAL LITERACY

4.1 Environmental Literacy

> Can citizens distinguish claims that are scientifically sound from those that are not? Ordinary citizens are generally not called on to judge the worth of major theories or potential advances in science. But they do make decisions based on the facts in advertisements, evidence in legal matters, information about their health, and issues concerning local environments and natural resources. An educated person should be able to distinguish the kinds of questions that can be answered by scientists and the kinds of problems that can be solved by science-based technologies from those that cannot be answered in these ways.
>
> PISA-OECD (2009, p. 127)

> In the coming decades, the survival of humanity will depend on our ecological literacy – our ability to understand the basic principles of ecology and to live accordingly. This means that ecoliteracy must become a critical skill for politicians, business leaders, and professionals in all spheres, and should be the most important part of education at all levels – from primary and secondary schools to colleges, universities, and the continuing education and training of professionals.
>
> Capra (2008, p. 1)

4.1.1 Scientific Literacy – A Brief Discussion

Before specifically defining environmental literacy, it is worth briefly discussing the broader concept of *scientific literacy*, from which it derives. Initial definitions of science literacy focussed on key 'facts' of content that people should understand, chosen from within the traditional disciplines of biology, chemistry, physics, geology and astronomy. In 1983, Miller proposed a more multidimensional character for scientific

literacy that marked an important consolidation of the concept by considering three *dimensions*; the nature of science, science content knowledge and an awareness and understanding of the societal impact of science and technology.

After a student leaves formal education, given the wide array of scientific and technical applications in everyday life, applying scientific literacy to everyday living might need to include everything from reading the label on a package of food, to repairing a car, to reading about the newest images from the Hubble telescope. In this context, Miller (1998) defined *civic scientific liter*acy as "a level of understanding of scientific terms and constructs sufficient to read a daily newspaper or magazine and to understand the essence of competing arguments on a given dispute or controversy" (p. 204).

But what exactly are the basic facts of science that a citizen needs in order to make informed decisions in our society? Is the acquisition of facts sufficient? Does a high score in a series of true/false or multiple-choice questions equate to scientific literacy? Is it possible to use a simple and straightforward measuring instrument to measure knowledge and understanding?

Laugksch (2000) has outlined the timeline of the number and type of instruments that have been developed to investigate particular aspects of students' scientific literacy. These include Cooley and Klopfer's (1961) *Test on Understanding Science*, Kimball's (1967) *Nature of Science Scale*, and Rubba and Anderson's (1978) *Nature of Scientific Knowledge Scale*. Such early measures focussed on measuring the acquisition of science knowledge. In 1992, Aikenhead and Ryan developed an instrument, *Views on Science-Technology-Society* that monitored students' views on a broad range of STS topics.

None of these instruments included items from all three dimensions of scientific literacy. At Miller's suggestion, the US Science & Engineering Indicators survey began to include items from these dimensions, allowing a fuller measure of this concept to be constructed for the first time (Miller 1983, 1992). All subsequent biennial S&EI surveys have included such questions (Miller 1987, 1992).

Other composite measures include Lord and Rauscher (1991), who based their short questionnaire on information contained in upper primary and middle school life science textbooks; Cannon and Jinks (1992); and Laugksch and Spargo (1996), who constructed a 110-item *Test of Basic Scientific Literacy* based on selected literacy goals recommended by the American Association for the Advancement of Science in the report *Science for All Americans*. As proponents of scientific literacy have tended to focus on what is learned by the time a student graduates from high school, this test instrument was specifically designed for students leaving high school and entering tertiary education.

Miller (1998) has outlined how the first US studies relied heavily on each respondent's self-assessment of their level of understanding of various science terms and concepts. Survey research literature had suggested that when respondents were offered a set of three choices, i.e., 'do you have a clear understanding of [construct A]', 'a general sense of [construct A]', or 'not much understanding of [construct A]', individuals selecting the clear understanding choice would be very likely to understand the concept, while individuals who were unsure about the concept or who did not understand it might select the middle or lower category. This approach, which was also used in national studies in Japan and some other countries, provided useful estimates, but clearly lacked the greater precision provided by direct substantive inquiries.

In 1988 Miller, Thomas, and Durant developed an expanded set of knowledge items that asked respondents direct questions about scientific concepts using a combination of open-ended and closed-ended items (Durant, Evans & Thomas, 1989). These items were found to provide significantly better estimates of public understanding than had been collected in any prior national study and subsequently a core set of knowledge items emerged that have been used in studies in Canada, China, the European Union, Japan, Korea, New Zealand, and Spain. To a large extent, these core items have provided a durable set of measures of a vocabulary of scientific constructs, with minor additions and deletions over the last three decades.

An example of the style of questioning used, beginning with a closed-ended inquiry was: 'When you read the term DNA in a newspaper or magazine, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?'. Respondents who indicated that they had either a clear understanding or a general sense of the meaning of DNA were then asked: 'Please tell me, in your own words, what is DNA?'. The interviewers then recorded the response verbatim. The responses were subsequently coded independently by teams of individuals knowledgeable about the definition and meaning of DNA.

This approach was found to produce highly reliable data in both the US and UK, and in subsequent US studies similar open-ended questions have been employed to measure the understanding of concepts such as acid rain, molecular structures, radiation, computer software, and the thinning of the ozone layer. Miller (1998) asserts that in general, open-ended questions provide a better measure of understanding than close-ended questions.

Given the difficulty of asking open-ended questions, especially in telephone interviews where respondents can simply hang up midway through an interview, Miller also developed a series of items in a true-false format, many of which have become part of the standard pantheon of questions used to determine scientific literacy. Such questions include 'Lasers work by focusing sound waves'; 'All radioactivity is man-made'; 'The earliest human beings lived at the same time as the dinosaurs'; and 'Antibiotics kill viruses as well as bacteria'.

The US National Academy of Sciences regularly measures the scientific literacy of Americans using the questions developed by Miller and in 1996 defined scientific literacy as "the knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (p. 22), important because "Americans are confronted increasingly with questions in their lives that require scientific information and scientific ways of thinking for informed decision making. And the collective judgment of our

people will determine how we manage shared resources - such as air, water, and national forests" (p. 11).

Two other comprehensive survey programs aimed at assessing scientific literacy are The Organisation for Economic Co-operation and Development's (OECD) *Programme for International Student Assessment* (PISA) and *Trends in Mathematics and Science Studies* (TIMSS) run by the National Center for Education Statistics (Martin, Mullis, Foy & Stanco, 2012). TIMSS focuses mainly on recall of content taught, so is of less relevance to this study.

Since 1997 PISA has measured scientific literacy, with the first survey taking place in 2000, and every three years subsequently. The latest survey was held in 2012. More than 70 countries have taken part in PISA so far, allowing them to track their progress in meeting key learning goals. PISA tends to focus on what might be called 'practical knowledge in action' and is the only international education survey to measure the knowledge and skills of 15-year-olds, an age at which students in most countries are nearing the end of their compulsory time in school.

Hurd (1958, cited in Bybee & McCrae, 2009) made a clear connection between science and citizenship, yet Osborne (2007) outlines how most school science programs still emphasise content and methods that educate future scientists rather than future citizens. Osborne argues that one of the outcomes of such an emphasis is the negative attitude of many students toward science. Roth and Lee (2004) concur and discuss how scholarly discussions of scientific literacy are often based on "three (generally unstated and perhaps unfounded) assumptions: scientific literacy is an attribute of individuals, science is the paradigmatic mode for rational human conduct, and school knowledge is transportable to life after school" (p. 264).

In contrast, scientific literacy has the explicit goal of preparing students for life and work as citizens, not scientists. The science questions in PISA therefore aim at evaluating how well students apply scientific ways of thinking to situations they could encounter in their everyday lives. This approach, making use of extensive stimulus material, allows

PISA to include scientific knowledge relevant to the science curricula of participating countries despite the differences in curricula between them. In capturing this idea, PISA defines scientific literacy in terms of

> "*Scientific knowledge* and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
>
> *Understanding* of the characteristic features of science as a form of human knowledge and enquiry
>
> *Awareness* of how science and technology shape our material, intellectual and cultural environments
>
> *Willingness* to engage in science-related issues, and with the ideas of science, as a reflective citizen" (PISA, 2009, p. 129).

In this definition, *knowledge* implies far more than the ability to recall information, facts, and names. The definition includes knowledge *of* science (knowledge about the natural world) and knowledge *about* science itself. Knowledge *of* science includes understanding fundamental scientific concepts and theories, while knowledge *about* science includes understanding the nature of science as a human activity and the power and limitations of scientific knowledge.

The PISA report further outlined how a "willingness to engage in science-related issues and with the ideas of science, as a reflective citizen" covered various aspects of attitudes and values that individuals may have towards science. A scientifically literate person will have an interest in scientific topics, think about science-related issues, be concerned about issues of technology, resources and the environment, and reflect on the importance of science in personal and social perspectives.

The paradigm shift implied by EE and LfS/ESD means the OECD's consideration of the complimentary relationship between science and technology in their definition of

scientific literacy is of particular relevance. Science and technology are closely related, although they differ in aspects of their purposes, processes, and products. Science and technology propose answers to questions and provide solutions to problems, but paradoxically may also create new questions and problems. Through public policies individuals make decisions that influence the directions of science and technology. This idea is central to the sustainability debate, with many putting faith in societies' abilities to solve problems reactively, rather than moving towards a new worldview.

Having measured the scientific literacy of students or citizens, the results must be reported. The Biological Sciences Curriculum Study (1993) and Bybee (1997) have developed a comprehensive theoretical five level scale, outlined in Table 4.1. Bybee says this framework provides "a unique perspective that gives direction to those responsible for curriculum, assessment, research, professional development, and teaching science to a broad range of students" (p. 86).

Bybee (1997) speaks of the difficulty of achieving multidimensional scientific literacy in all scientific domains. Indeed, it would take a lifetime and is probably impossible. Even scientists, experts in one discipline, may have a very poor understanding of concepts in an unrelated field, and a poor appreciation of the impact of science and technology on society. Thus, assessing scientific literacy during school years is no indication of the final level of literacy a person will attain. It *can* be used as a measure of how effectively the study of science has been in establishing attitudes, values, basic skills, knowledge and understanding of science. As the US National Academy of Sciences (1996) stated "scientific literacy has different degrees and forms; it expands and deepens over a lifetime, not just during the years in school. But the attitudes and values established toward science in the early years will shape a person's development of scientific literacy as an adult" (p. 22).

Table 4.1

Scale of Scientific Literacy

Literacy Level	**Indicators of the Literacy Level**
Scientific illiteracy	Students cannot relate, or respond to, a reasonable question about science. They do not have the vocabulary, concepts, contexts, or cognitive capacity to identify the question as scientific.
Nominal scientific literacy	Students can recognize a science concept, but the level of understanding indicates fundamental misconceptions.
Functional scientific literacy	Students can correctly describe a scientific concept, but have a limited understanding of it.
Conceptual scientific literacy	Students have developed some understanding of the major conceptual schemes of a discipline and can relate those schemes to their general understanding of science. Students at this level of literacy can also understand procedural abilities and the processes of scientific inquiry and technological design.
Multidimensional scientific literacy	A student with this perspective of scientific literacy can incorporate an understanding of science that extends beyond the concepts of scientific disciplines and procedures of scientific investigation and includes philosophical, historical, and social dimensions of science and technology. Students have developed some understanding and appreciation of the relationship of science and technology to their daily lives. This student begins to make connections within scientific disciplines, between science and technology, and the larger issues challenging society.

Assessing scientific literacy during the students' years at school indicates whether the 'seeds of literacy' have found their place in a students' mind, nothing more. Nonetheless, the goal can be seen to have clearly informed the design of the NSW Science Syllabuses, with their focus on the history of science, the application and uses of science, the implications of science for society and the environment and current issues in research in the Prescribed Focus Areas. These PFAs tie in with the OECD's definition

of a scientifically literate person. The Board of Studies (2003) states that "Being scientifically literate means that students can apply their knowledge of scientific concepts and processes to the evaluation of issues and problems that may arise and to the decisions that they make in their daily life, about the natural world and changes made to it through human activity (p. 18).

4.1.2 Beyond Scientific Literacy to Environmental Literacy

> Everyone now makes decisions that have implications for the natural system – as a worker, as a consumer, as a parent or as a member of a community group. Our urban structures, our legal system, our economic development choices, our use of transport, our recreations and amusements, our diet and the way we live our daily lives all have significant impacts on the natural environment. The argument for universal environmental literacy is simply an argument that we should understand the effects of our choices, rather than continuing to do unnecessary damage through our ignorance.
>
> Lowe (2002, p. 1)

A number of studies, including Dunlap (1995), Buckeley (2000) and Eurobarometer (2001), have attempted to measure how well lay-citizens understand the causes and effects of major environmental problems. Despite high levels of education and good access to the media, citizens of developed countries appear nonetheless to have very shaky notions of the causes and effects of environmental problems. Alarmingly, studies of scientists have not fared much better, with many unsure of their answers.

In today's world, where young people are faced with escalating environmental challenges including climate change, depletion of resources, and environmentally-linked illnesses, the need for *environmental literacy* seems very urgent. Stone (2009) has stated "this generation will require leaders and citizens who can think ecologically, understand the interconnectedness of human and natural systems, and have the will, ability, and courage to act" (p. 2).

Although not explicitly defined, there is a fairly broad consensus amongst a range of educators as to what environmental literacy (also referred to as *eco-literacy*) entails and the concepts, skills and processes that learners ought to know and demonstrate. Lane, Wilke, Champeau, and Sivek state that environmental education has "the ultimate goal of producing informed and skilled citizens who are willing and able to take action to resolve environmental issues, or promoting the acquisition of responsible environmental behaviour" (1995, p. 36). Orr (1992) believes the goal of environmental education is to understand "how people and societies relate to each other and to natural systems, and how they might do so sustainably" so that "the ecologically literate person then understands the dynamics of the environmental crisis which includes a thorough understanding of how people (and societies) have become so destructive" (p. 92).

The starting point for a definition of environmental literacy might be the idea of 'ecological literacy', that is, the ability to understand the natural systems that make life on Earth possible; what Commoner (1971), called the Four Laws of Ecology: everything has to go somewhere; everything is connected to everything else; there is no such thing as a free lunch; and nature knows best. However, simply understanding the principles of organisation within ecosystems; producers, first order consumers, second order consumers, decomposers, the carbon/oxygen, nitrogen and water cycles and so forth, is but the tip of the iceberg.

These concepts make up a very small part of the NSW Science syllabuses in Stage 4 and 5, and are generally well understood by students. However, the whole thrust of EE and EfS from the *Melbourne Declaration*, to the *National Action Plan*, through to the NSW *Environmental education policy*, suggests that the goal of LfS/ESD is for students to have a broad and deep understanding of how such principles can be applied in the creation of sustainable human communities.

The term *eco-literacy* was coined by educator David W. Orr and physicist Fritjof Capra in the 1990s. Orr and Capra envisage a sustainable society of ecologically literate citizens that does not destroy the natural environment on which it depends. Orr (1992) argues that by failing to include ecological perspectives in education, students have been

taught that ecology is unimportant and that a shift in perceptions must occur because eco-literacy requires not only a mastery of the relevant subject matter, but the creation of meaningful connections between head, hands, and heart. Orr argues that an environmentally literate person understands the dynamics of the main environmental crises (the food crisis, the energy crisis and the biodiversity crises) and thoroughly understanding of how societies have become so destructive.

In Orr's view, this planetary crisis requires fundamental changes in the way humans relate to each other and to the environment. In terms of educational theory, this interpretation of the environmental crisis separates EfS/ESD from other environmental education approaches, including education *for* the environment, which continue to maintain "techno-centric characteristics" (Orr, 1992, p. 1).

This implies an understanding of ecological systems underpinned by systems thinking. Systems thinking, as discussed in Section 2.3, is the recognition of the world as an integrated whole rather than a collection of individual elements. Within systems thinking, the basic principles of organisation are more important than the analysis of various components of the system in isolation. Systems thinking is necessarily part of eco-literacy, used in order to understand complex interdependence of ecological systems, social systems and other systems on all levels.

Thus, environmental literacy aims to replace fragmentary thinking with new cognitive and social capacities necessary for the design of sustainable ways of living, and calls for a rejuvenation of civic culture and the rise of an ecologically literate citizenry that understands global issues. Environmental literacy is however, like any science content, grounded in teachers' and students' daily lives and experiences and so Jickling (1997) sounds a warning note that definitions, such as those outlined, risk becoming loaded. "It is one thing for an individual to assess the range of available environmental options, - it is quite another for a teacher to insert a heavily loaded prescription into anything educational" (p. 96). Indeed, any teaching of environmental science needs to acknowledge the levels of uncertainty in our current understanding, and be mindful that decisions about the natural world will have social, political and economic dimensions.

Whether greater levels of environmental literacy alone can address the infamous ‘values-action gap’ is less certain.

Are members of the public divided about climate change because they don't understand the science behind it? If they knew more basic science and were more proficient in technical reasoning, would public consensus match scientific consensus? A recent study (Kahan et al, 2012) suggests that the answer to both questions is no. The authors of the study use the term *cultural cognition* to describe the unconscious tendency of people to fit evidence of risk to the pre-existing positions which predominate in the groups to which they belong. Cultural cognition, in other words, is the process by which individuals' group values shape their perceptions of societal risks.

This large study (N = 1540) found that as members of the public become more scientifically literate and numerate, individuals belonging to opposing cultural groups become even more divided on the risks posed by climate change, and that individuals with higher science comprehension were simply better at fitting the evidence to their group’s positions. Surprisingly, the most scientifically literate and numerate subjects were slightly less likely to see climate change as a serious threat than the least scientifically literate and numerate; rather they were those amongst whom cultural polarisation was greatest.

The authors suggest that this evidence reflects a conflict between two levels of rationality. At the individual level citizens use of their knowledge and reasoning capacities to form perceptions of risk that express their cultural commitments, while at the same time, and at the collective level, they fail to agree on the best available scientific evidence in order to promote their common welfare. The study suggests the need for science communication strategies that reflect a more sophisticated understanding of cultural values in order to effectively dispel this “tragedy of the risk-perception commons” (Kahan et al., 2012, p. 2) by informing through reason, while motivating through emotion.

Current modes of education emphasise theories over values; concepts rather than people; answers instead of questions and ideology; and efficiency rather than conscience. The same could be said about how teachers currently prepare students to think about the natural world. The only people who managed to live sustainably on our planet for any length of time have not had the kind of education that we in 'the west' value so highly. Educators in the field of LfS/ESD seem to be stuck trying to integrate the concepts of EE into existing curricula and school structures, when a new paradigm is needed to replace this type of education that no longer serves us. In 1997, Gough noted that "although the environmental content of school curricula has increased, most schools are not involved in education for the environment… (schools are) incorporating environmental content (knowledge and awareness) into their existing curricula rather than engaging in the kinds of social action that are being undertaken by other community agencies and activists." (p. 77).

Such a pessimistic view should sound a little dated a decade later, when the *National Action Plan* (2009) and NSW *Environmental education policy* (2002) are in place, although it is clear that there is a very, very long way to go. No matter what the amount of EE content within Australian curricula, very little is delivered as education *for* the environment or as ESD. Although more Australian students are aware of the environment and of the need to protect or improve it, the process of transferring increased awareness into an increased action or participation for change continues to be slow.

Lowe (2002) feels that the need for environmental literacy makes "obvious demands for changes" (p. 4) to education in general and science education in particular. This can be achieved by teaching science, not as a body of knowledge, but as a *process* of trying to understand the natural world and the impacts of people on it, with "explicit recognition of the levels of uncertainty in our current understanding, in terms both of basic knowledge of the local environment and general understanding of complex natural systems" and acknowledging that "applying our understanding of the natural world to

real decisions is inevitably a complex process that has social, political and economic dimensions" (p. 4).

Alongside students understanding the processes of science, Cudaback (2008) feels they must also have positive attitudes towards it. Shifting students' thinking about science from a set of facts to science as a process, a tool students can use, and a way to understand the real world, Cudaback feels, will allow them to use science for effective environmental decision making. This in turn, should lead to changed behaviours. Hungerford and Volk (1990) concur, because it aspires to influence the behaviour of the students who study it, EE is fundamentally different from other educational disciplines. This is reflected in the behavioral component in most definitions of environmental literacy.

Monroe (2003) distinguishes between five categories of environmental behaviours; *environmental activism* (e.g., actively participating in or leading environmental initiatives); *non-activist political behaviours* (e.g., joining organisations, voting for pro-environmental political parties, signing petitions, making donations); *consumer behaviours* (e.g., purchasing eco products, recycling, reducing energy use, and changing patterns of consumption); *ecosystem behaviours* (e.g., planting native bird friendly gardens, counting wildlife populations, promoting prescribed fire, rescuing wildlife) and *other behaviours* specific to an individual's expertise or workplace (e.g., reducing waste in the production process, auditing the energy efficiency of buildings houses, suing a polluter, etc.).

Therefore, it can be seen that with environmental literacy comes a shift in perceptions. The urgent need to protect ecosystems is not simply the belief of a committed environmentalist; it is a biological imperative for the survival of human society, and will become a basic principle for prioritising thought and action in a sustainable society. LfS/ESD in schools has the potential to have a positive multiplier effect throughout the broader population. For example, there are over one million school students in NSW, equating to approximately 16 percent of the NSW population. This means more than 500,000 NSW families potentially have some contact with ESD as they discuss 'what

happened at school today' around the dinner table. LfS/ESD at school, leading to a functional level of environmental literacy, can initiate gradual and cumulative changes to everyday family living.

Environmental literacy is a powerful concept if used as the starting point for an integrated approach to environmental problems. It is clear that environmental literacy is emerging as a new educational paradigm, underpinned by ideas of holism, systems thinking, sustainability, and complexity.

4.2 Measuring Environmental Literacy

If environmental literacy is a concept that is easy to understand, but difficult to define, then measuring eco or environmental literacy is an equally tricky proposition. Although much discussed in the literature, there appears to be very little which addresses how an understanding of the concepts, values and attitudes that underpin Learning for Sustainability/Education for Sustainable Development would actually be measured.

The broader idea of scientific literacy has been much discussed and studied and many attempts to measure it have been made. Scientific literacy has taken its place alongside numeracy and literacy as not only a right, but as a requirement for responsible participation in society, helping the average person to make better decisions and enrich their lives. This shift in thinking took place in the late 1980s and early 1990s, following the publication of *Benchmarks for Scientific Literacy* (1993) by the American Association for the Advancement of Science.

Science literacy has also been an important element of the standards movement in education, and science literacy documents have been drafted with the explicit intent of influencing educational standards, as a means to drive curriculum, teaching, assessment, and ultimately, learning nationwide. More recently, the idea that LfS/ESD should underpin all learning suggests that a specific concept of environmental literacy needs to not only be defined but measured, to ensure LfS/ESD moves from planning and policy into explicit learning in classrooms.

Orr (1991) has suggested that "no student should graduate … without a basic comprehension of the laws of thermodynamics, the basic principles of ecology, carrying capacity, energetics, least-cost, end-use analysis, how to live well in a place, limits of technology, appropriate scale, sustainable agriculture and forestry, steady-state economics, environmental ethics" (p. 52), but does not address how these basic comprehensions should be measured.

Klemow (1991) has outlined how sustainability is both a qualitative and quantitative condition; demonstrating the human capacity to survive over time. Qualitative in that humans desire well-being in addition to mere survival, but well-being is a concept that is difficult to measure; and quantitative because the natural capital and ecological carrying capacity of the Earth are able to be measured with foot-printing tools. It is an ecological imperative that human society can exist only within the carrying capacity of an ecosystem. Our society has created industries, processes and institutions that are destroying the ecosystem's ability to support life. This has occurred as a direct result of a lack of ecological understanding and a lack of agency. Ecological literacy aims to replace fragmentary thinking with new cognitive and social capacities necessary for the design of sustainable ways of living.

UNESCO (2005a) also discussed how both qualitative and quantitative methods could be used to track the success of the Decade of Education for Sustainable Development, as the "adoption of values and changes in behaviour cannot adequately be captured by numbers alone" (p. 43). Some of the data used to give an indication of the success of the decade includes the number of countries with sustainable development (SD) in basic education curricula; monitoring the number of mentions of SD in nation and international reporting on ESD; the number of schools and non-formal programs modelling SD approaches and adopting SD principles; and the number of teacher training courses with an integrated SD theme.

A quick Internet search will reveal a variety of quizzes and tests entitled 'test your scientific literacy' or 'how eco-literate are you?'. On-line debate then rages with participants debating whether the facts tested are relevant or not. The contentious debate

surrounding global warming only makes testing of accepted scientific facts more fraught. PISA and the USA's National Science Foundation (NSF), two well-established methods of assessing scientific literacy can be used to provide some basis for developing a measuring instrument specifically for the purposes of measuring environmental literacy.

4.2.1 Measuring Environmental Literacy in Students

The Programme for International Student Assessment (PISA) tests are given world-wide to 15 year-old students who are nearing the end of their minimum formal schooling. The PISA definition of scientific literacy considers what students of this age should know, value and be able to do as preparation for life in modern society. The tests thus try to assess the competencies that are characteristic of science and scientific enquiry: identifying scientific issues, explaining phenomena scientifically, and using scientific evidence. The ability of students to perform these competencies is made up of their scientific knowledge, both knowledge of the natural world (in the areas of chemistry, biology, earth and space sciences, and technology); knowledge about science itself (including knowledge about scientific enquiry and scientific explanations); and their attitudes towards science-related issues.

The PISA definition of scientific literacy (OECD, 2009) is necessarily tailored for assessment purposes, and consists of four interrelated aspects:

- *Context* - life situations recognised to involve science and technology;
- *Knowledge* - understood on the basis of knowledge of the natural world, and knowledge about science itself;
- *Competencies* - scientific competencies demonstrated such as identifying scientific issues, explaining phenomena scientifically, and drawing conclusions based on evidence; and
- *Attitudes* - indicating an interest in science, support for scientific enquiry, and the motivation to act responsibly towards, for example, natural resources and environments.

Therefore, PISA is concerned with both the cognitive and affective aspects of students' competencies in science. The cognitive aspects include students' knowledge and their capacity to use this knowledge effectively when carrying out certain cognitive processes that are characteristic of science and scientific enquiries. In setting the context for test items, PISA uses issues to which scientific knowledge can contribute and which will involve students, either now or in the future, in making decisions.

Each PISA test unit is comprised of a group of independently scored questions of various types, accompanied by stimulus material (such as text, photographs, graphs, diagrams and tables) that establishes the context for the items. Four types of items are used to assess the competencies and scientific knowledge identified in the framework:

- *Simple multiple-choice* items which require the selection of a single response from four options;
- *Closed constructed-response* items;
- *Complex multiple-choice* items which require students to respond to a series of related "Yes/No" questions; and
- *Open constructed response* items which require a relatively extended written or drawn response from students.

Simple multiple-choice items make up about one-third of the items, *closed constructed response* and *complex multiple-choice* items make up another third, and *open constructed response* items make up the remainder.

As discussed earlier, attitudes towards science can have a significant effect on scientific literacy. In the 2006 PISA, science was the major domain assessed, and for the first time an assessment of students' attitudes and values was included. This was achieved through contextualised questions posed immediately after, and related to, the test questions in many units (Bybee and McCrae (2009). The questions relating to student attitudes were different from the others, in that they had no right or wrong answer. They related to the same scientific issue as the other questions in that unit, but they asked

about students' attitudes towards the issue. These questions were divided into four sub-categories:

- interest in science;
- support for scientific enquiry;
- self-belief as science learners; and
- responsibility towards resources and environments.

In education theory, understanding of content lies in the cognitive domain, while attitudes lie in the affective domain. Negative attitudes, such as fear of the impact of climate change, can act as an affective filter and an impediment to future action, through denial about the state of the world, or an individual's denial of responsibility for its well-being, or the lack of a sense of empowerment to make a difference. Alternatively, Thiengkamol and Thiengkamol (2012) indicated that environmental behaviour can be influenced when EE develops positive attitudes in people, allowing them to participate in, and take responsibility for the protection and conservation of the environment. Kaiser, Wolfing, and Fuhrer (1999) and Makki, Abd el Khalick, and Boujaoude (2003) have also found environmental attitude to be a strong predictor of pro-environmental behaviour. Attitudes are therefore an important part of measures of environmental literacy, and for this reason questions which may shed light on the attitude towards sustainability issues in the subject's own household, as well as the school they attend, have been included in the measuring instrument for this thesis.

The 2009 PISA science results from were reported on a single science scale with a mean of 500 and a standard deviation of 100, using six levels of proficiency (PISA, 2009). PISA does not perceive scientific literacy as a single discrete entity or typological classification, and so does not categorised students as being either scientifically literate or scientifically illiterate. Rather, a student sits within a continuum from less developed to more developed scientific competencies that include proficiency levels, different domains of scientific knowledge, and attitudes toward science. Level 6 is the highest

level of proficiency and Level 2 has been established as the baseline level of scientific literacy.

Students achieving below Level 2 are considered to have not demonstrated the scientific knowledge and skills that will enable them to participate actively in life situations related to science and technology. A student with less developed scientific literacy might be able to recall simple scientific factual knowledge about a physical system and use common science terms in stating a conclusion. A student with more highly developed scientific literacy might demonstrate the ability to use conceptual models to explain natural phenomena, formulate explanations, evaluate alternative explanations of the same phenomena, and communicate explanations with precision.

In 2011, Maryland became the first state in the USA to require students to be environmentally literate as a high school graduation requirement. The Maryland State Board of Education and Maryland Association for Environmental and Outdoor Education developed the *Maryland Environmental Literacy Curriculum Standards* (2012), against which each school must align their own multi-disciplinary EE program. There are eight state standards: Environmental Issues; Interactions of Earth's Systems; Flow of Matter and Energy; Populations, Communities and Ecosystems; Humans and Natural Resources; Environment and Health; Environment and Society; and Sustainability. Standard Seven ("The student will analyze how the interactions of heredity, experience, learning and culture influence social decisions and social change") and Eight ("The student will make decisions that demonstrate understanding of natural communities and the ecological, economic, political, and social systems of human communities, and examine how their personal and collective actions affect the sustainability of these interrelated systems") are quite a departure from the traditional, and clearly reference EfS/ESD literature. However no reference is made as to how students will be assessed as having met the outcomes of the eight Standards.

Other American States have followed Maryland's lead. Connecticut's Environmental Literacy Plan (n.d.) states that the future health of the state "depends on its citizens being environmentally literate and able to make informed choices about environmental issues

such as water use, air quality, and land development", so that they can "understand different points of view, analyze problems, balance competing needs, and take informed action" (p. 3). The plan sets out a goal whereby the state will conduct a publicly reported survey of the environmental literacy of the general population of Connecticut every few years, in order to make modifications to the environmental education learning program. The plan gives no hint as to how this will be achieved.

The work of Bybee (1997), O'Riordan (1981), Roth (1992) and Orr (1990, 1992) can be used to develop a scale to identify levels of environmental literacy. These allow a measuring instrument to scale the data collected and place students on a continuum of environmental literacy. These levels are outlined in Table 4.2.

Table 4.2

Scale of Environmental Literacy

Environmental Illiteracy	
Knowledge	A student has little understanding of environmental issues and/or the idea of an environmental crisis and demonstrates many misconceptions about environmental issues.
Beliefs	A student believes that environment is a resource to be used by human beings; that all economic growth is good, and that science and technology will solve and/or manage any problems. Such a student may be suspicious that environmental education and social change are necessary.
Nominal Environmental Literacy	
Knowledge	A student can recognise some basic terms used in communicating about the environment and may possess misconceptions about and provide naïve explanations of environmental systems. Such a student is beginning to identify environmental problems and the issues surrounding proposed solutions.
Beliefs	A student is developing awareness and sensitivity towards the importance of natural systems and the human impacts on them, and does not believe that economic growth and resource exploitation can continue. Such a student recognises the need for effective environmental management agencies at national and local levels and that raising environmental awareness and concern is necessary within society/education.

Functional / Operational Environmental Literacy	
Knowledge	A student regularly uses environmental vocabulary with the correct definitions and in the appropriate context and understands the organisation and functioning of environmental systems and their interaction with human systems. Such a student possesses the knowledge and skills to act on local problems and be involved with environmental concerns at the education level.
Beliefs	A student is personally committed to environmental quality and believes in the intrinsic importance of nature for defining and sustaining humanity. Such as student rejects materialism and demonstrates a lack of faith in large-scale technology and continued economic growth. They have a personal commitment to EE and the production of an environmentally literate and committed citizenry.
Highly Evolved Environmental Literacy	
Knowledge	A student possesses a thorough understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainability, along with a thorough understanding of the dynamics of the environmental crisis which includes a thorough understanding of how people (and societies) have become so destructive. Such a student possesses an understanding of models of sustainability and associated environmental perspectives and is able to synthesise environmental information and act upon that synthesis in ways that lead to environmental sustainability through EE.
Beliefs	A student believes in the intrinsic importance and preservation for defining nature and sustaining humanity, and has faith in the cooperative capabilities of societies to establish self-reliant communities as a base for sustainable resource use. Such as student demonstrates a passionate and committed belief in the production of an environmentally literate, committed and active citizenry, and that humanity should live simply, so that others can live.

Before the 1990s, there were not many attempts to measure environmental literacy. An early attempt was the *Revised Ecology Scale* (Maloney, Ward, & Braucht, 1975), which was directed at adults and included verbal commitment, actual commitment, affect and knowledge scales. Later came the *Children's Environmental Attitude and Knowledge Scale* (CHEAKS) developed by Leeming, Dwyer, and Bracken (1995) for students in grades one to seven and including knowledge, attitude and behaviour scales; the *Environmental education literacy/needs assessment project* (Marcinkowski & Rehrig, 1995) for high school students, including knowledge, affect, skills and behaviour scales; and the *Middle School Environmental Literacy Instrument* (MSELI), developed by Bluhm, Hungerford, McBeth, and Volk (1995) for students in grades six to eight, including knowledge, affect, skills, and behaviour scales.

In 1996, Bogan and Kromrey used the *Florida Environmental Literacy Survey* (FELS) to determine the environmental literacy of high school students. They defined

environmental literacy as being made up of five aspects: knowing ecology; being attitudinally predisposed to the environment; valuing responsible environmental behaviours; participating in responsible environmental behaviours; and knowing political action strategies. Since 1989, the Florida Legislature has required that public schools act as the primary delivery system to create environmentally literate citizens. Bogan and Kromrey found that the levels of environmental literacy assessed using their measuring instrument were low and that EE delivered through science content did not fulfil the expressed intentions of the 'awareness to action' model of EE.

In 1999, the Dutch National Assessment Program, studied environmental knowledge, attitudes and behaviour in a nationwide sample of more than 9,000 9th-grade students from 206 secondary schools. The authors found that 57 percent of the 9th-grade students had a positive attitude toward the environment, and 35 percent were prepared to take extra pains or to make financial sacrifices for the environment. The students' knowledge about environmental problems was found to be low and often incorrect. The correlation between environmental knowledge, attitudes, and behaviour was weak, but the relationship between the willingness to make personal sacrifices and environmentally responsible behaviour was substantial. Indeed, environmentally responsible behaviour was more strongly connected with willingness to make sacrifices, than with a positive attitude toward the environment (Kuhlemeier, Van Den Bergh, & Lagerweij, 1999).

A 2002 study by Barraza and Walford compared seven to nine year old children in England and Mexico in order to explore the extent to which the culture and ethos of a school effected the formation of environmental knowledge, perceptions and attitudes. They concluded that schools with the strongest orientation in environmental studies seem to transmit environmental information more effectively than schools with no environmental policies.

In 2003, Makki, Abd-El-Khalick, and BouJaoude surveyed 660 Lebanese students from grades 10 and 11 in order to assess their environmental knowledge and attitudes. The findings were that the students had less than adequate environmental knowledge,

although their attitudes to the environment were positive. The authors felt that students did not possess the necessary knowledge to allow them to make decisions regarding environmental issues, and that their school experiences (Lebanon introduced environmental education into the general curriculum in 1997) were not making a difference to their environmental knowledge.

A Korean study, by Chu et al. (2007) investigated the environmental literacy levels of Year 3 students. They developed a measuring instrument called the *Environment Literacy Instrument for Korean Children* (ELIKC), which measured the dimensions of knowledge, attitude, behaviour, and skills using 69 items. The survey took 80 minutes to complete and was administered to 969 students. The results indicated that the correlation between attitude and behaviour was the strongest; and between knowledge and behaviour the weakest. They also found that sex, the education level of parents and the source of information about the environmental affected all categories of environmental literacy.

In 2008, a study in Bangladesh was undertaken by Alam, Jahan, Jahir, and Koji to investigate the environmental literacy of secondary level students. Specifically, the study aimed to measure the environmental knowledge of students, to explore their environmental attitudes and practices and the environmentally-friendly practices of the schools involved. A three-part questionnaire was used, comprising of 15 multiple-choice questions related to environmental content knowledge, a 15-item attitude scale using a five-point Likert-type response format, and six questions on environmental practices. There was also a 10-item observation of the school's environmental practices. They found that although their environmental knowledge of girls lagged behind boys, girls had more positive attitudes towards the environment. Students had good levels of environmentally related practices, but the practices of the schools were not sufficient to support the development of environmentally literacy in students, especially in rural schools.

In the same year Alp, Ertepinar, Tekkaya, and Yilmaz investigated the environmental knowledge and attitudes of elementary students in Turkey, including how

what they referred to as 'self-reported environmentally friendly behaviour' is related to environmental knowledge, behavioural intentions and environmental affects. Two measuring instruments were used to survey 1,140 students: the *Children's Environmental Attitudes and Knowledge Scale*, and the *Locus of Control Scale*. The researchers found that behavioural intentions, environmental affects and locus of control were significant predictors of self-reported environmentally friendly behaviour, and that students' behaviour towards the environment was independent from their low level of knowledge of environmental issues.

Meanwhile, in Israel, a 2008 study by Negev, Sagy, Garb, Salzberg, and Tal conducted a national survey of 6th and 12th-grade students to evaluate their knowledge, attitudes and behaviours as a measure of their environmental literacy. They did not find any significant correlation between knowledge and behaviour. An interesting aspect of their study was the finding that the presence of an adult who mediated children's relationship to nature was strongly related to environmental attitudes and behaviour. Schools appeared to have only a modest effect on environmental attitudes and behaviours.

The 1995 MSELI was modified for the National Environmental Literacy Assessment Project, and redeveloped into the *Middle School Environmental Literacy Survey* (MSELS) for a very large 2008 study undertaken by the US Environmental Protection Agency. This study aimed to develop an instrument to measure environmental literacy and provide baseline environmental literacy data for 6th and 8th graders across the United States.

The MSELS was developed and refined by McBeth, Hungerford, Marcinkowski, Volk, and Meyers and measured ecological knowledge, verbal commitment, actual commitment (environmental behaviour), environmental sensitivity, general environmental feelings, issue identification and analysis skills and action planning. This meant it covered the four domains the authors felt were critical to environmental literacy; Knowledge, Affect, Cognitive Skills and Behaviour. The MSELS consisted of multiple-choice and Likert-type items and was designed to be administered during a

class period. Unfortunately, as the instrument was designed for commercial purposes, no hint as to the content of the items available, but it was comprised of four scales:

- *Ecological Knowledge*

  17 item multiple-choice items,

- *Environmental Affect*

  a 12-item Verbal Commitment (What You Think About the Environment) scale, presented in five-point Likert-type response format

  an 11-item Environmental Sensitivity (You and Environmental Sensitivity) scale, also in five-point Likert-type response format

  a two-item Environmental Feeling (How You Feel About the Environment) scale in five-point Likert-type response format

- *Cognitive skills*

  three multiple-choice items on Issue Identification

  six multiple-choice items on Issue Analysis

  ten multi-response items on Action Planning

- *Behaviour –*

  a 12-item Actual Commitment (What You Do About the Environment) scale in five-point Likert-type response format.

A number of environmental literacy components were not measured by this instrument because they were deemed to not be developmentally appropriate for middle school students and would require substantial time to measure and score properly. As such, knowledge of environmental problems and issues, knowledge of alternative solutions and action strategies and some issue-related skills were not assessed.

The study found that the highest scores were in the domain of Ecological Knowledge, with slightly lower scores in Environmental Affect and Behaviour. The lowest scores were observed in the component of Cognitive Skills.

In 2011, Lillah, Viviers, Venter, and Elizabeth developed and tested a theoretical framework to assess the level of environmental literacy of students in the Faculty of Business and Economic Sciences at Nelson Mandela Metropolitan University. They assumed that environmental literacy was measurable in terms of the behaviours of individuals towards the natural environment, and that these behaviours were in turn dependent upon the ecological and business knowledge (so-called 'green management skills') and environmental values exhibited by individuals. The study developed a measuring instrument to assess the variables identified in the theoretical framework. They found that values and attitudes towards the environment were positive, but not reflected in a wide range of behaviours, with ecological and business knowledge having the most influence on pro-environmental behaviours.

A study conducted in Malta by Mifsud (2011) made similar findings: that while the overall attitude of students towards the environment was strongly positive, they did not practise many eco-behaviours.

Finally, in 2012, Dijkstra and Goedhart developed a measuring instrument known as the *Attitudes towards Climate Change and Science Instrument* (ACSI), which measured students' attitudes towards science, their pro-environmental behaviours, and their attitudes and knowledge about climate change. This questionnaire consisted of 63-items and surveyed 671 secondary school students in France, Italy, The Netherlands, Norway and Spain. Their correlations showed weak but significant relationships between science-related attitudes and attitudes towards climate change and the environment, with the highest scores from younger students, females and students with high science grades.

4.2.2 The Environmental Literacy of Teachers

The general trend in education over the last hundred years has been towards specialisation. This, combined with the increasing speed of information flow, has led to a disconnect between the average person and the experts who are capable of understanding the problem. Indeed, the experts themselves have become so specialized that few are able to tackle the broader, multi-dimensional problems people see as important. This adds another layer of complexity to the issue of environmental literacy, as teachers must themselves have a high level of environmental literacy if they are to successfully develop environmental literacy in their students.

There appears to have been little investigation of the environmental literacy levels of teachers. Perhaps it is just assumed that science teachers will have the necessary knowledge, values and attitudes to successfully implement ESD.

In the early 1990's, Spork surveyed over 200 Brisbane primary school teachers. The purpose of her study was to determine the level of EE practice, and whether the emphasis of teachers was on education *about* the environment, education *in* the environment or education *for* the environment. The sampled teachers considered education *in* and *about* the environment to be more important than education *for* the environment, even though the research and literature argue that education *for* the environment is central to moves towards ESD.

This group of teachers had received very little in the way of professional preparation to teach EE. Only 4.9 percent of teachers had received pre-service EE training and only 6.6 percent had undertaken in-service training in EE. Spork (1992) concluded that although primary school teachers consider EE to be an important learning area and had a positive attitude towards it, they seem to lack the skills and knowledge to teach it successfully. Spork consequently identified the provision of further or restructured teacher education as the main priority for EE.

Cutter (2001) and Cutter-Mackenzie and Smith (2003) investigated Australian primary school teachers' knowledge and beliefs about EE using a combined-methods approach and the theoretical concept of ecological literacy. They contend that Australian (specifically Queensland) primary school teachers vary in their commitment to EE and lack content knowledge of environmental concepts and EE and are likely to be functioning at the level of environmental illiteracy or nominal environmental literacy. They also found that primary school teachers tended to dismiss the importance of content knowledge, preferring to focus upon attitudes and values towards EE and environmental concepts. It has already been noted that in the NSW Science Syllabuses, the focus is more on attitudes and values than content related to environmental and sustainability issues, so perhaps this attitude is not a surprise. Indeed, LfS/ESD implicitly values attitudes over knowledge as a means to implement action on sustainability.

Cutter-Mackenzie and Smith concluded that such levels of ecological literacy in teachers are inadequate if ecologically literate students and thus an ecologically literate citizenry are to be developed within schools. In the intervening years since these studies, it is doubtful that any aspect of teacher training has changed sufficiently to have had a marked impact on the environmental literacy levels of teachers.

4.3 Summary

It seems surprising that the Decade for Education for Sustainable Development is drawing to a close, yet there have been few attempts in educational research to define or measure the concept of environmental literacy in either students or teachers. Despite many plans and policies, there is little evidence of ESD in current and emerging Australian curriculums. New teachers beginning their careers as educators are little better equipped to teach from an ESD perspective than those approaching retirement. Despite worthy aspirations and a stated place as one of the legs of the tripod upholding it, the National Science Curriculum appears to pay little more than lip service to ESD.

The aim of this thesis is to develop and implement a measuring instrument that gives some insight into the environmental literacy of students. It represents one of the early attempts to do so. It is hoped that over time the concept of environmental literacy will become better defined, more broadly accepted and more commonly measured.

CHAPTER 5

METHOD

5.1 Introduction

This section discusses the measuring instrument used in this thesis. As it is believed that this study represents the first attempt in Australia to quantitatively measure environmental literacy of students, the measuring instrument (although informed by other existing measures of scientific and environmental literacy) was designed by the author.

Section 5.2 discusses the theoretical framework used to develop the measuring instrument. Four domains of environmental literacy were measured; Knowledge, Attitude, Awareness and Action, and this section outlines the type of questions utilised in each scale, the links to the NSW Science Syllabus, and the values assigned to each question.

In Section 5.3 the composition of the research sample is described, and in Section 5.4 summaries of the student population and environmental focus of the ten schools surveyed are given.

Section 5.5 outlines the process of data collection used in this study, and Section 5.6 discusses how numerical values were assigned to the data, so that the *Australian Environmental Literacy Quotient (AELQ)* could be determined.

5.2 The Development of the Measuring Instrument

Since environmental literacy is a multi-dimensional and complex concept, it is difficult to assess all its aspects and components. A key debate in the EE literature revolves around the relations between knowledge, attitudes, and behaviour (e.g., Scott & Willits, 1994; Ungar, 1994; Marcinkowski, 1998; Simmons, 1998; Kaiser et al., 1999; Kuhlemeier, Van Den Bergh & Lagerweij, 1999; Olli, Grendstad & Wollebaek, 2001; Courtenay-Hall & Rogers, 2002; Kollmuss & Agyeman, 2002; Makki et al., 2003; Said, Yahaya, & Ahmadun, 2007). In general, the frameworks developed for environmental

literacy (discussed in Section 4.2.1) do have features broadly in common. They reflect at least four of the 1977 Tbilisi Declaration categories of objectives, namely Knowledge, Affect, Skills and Participation, and they address major themes of the Environmental Education movement, namely the natural world, environmental problems and issues and sustainable solutions to these problems and issues.

Based on the theoretical frameworks, a series of items was developed based on these categories and themes, including questions to measure knowledge and awareness of issues, questions about actions and practices, and questions about values and attitudes. Careful attention was paid to making each item suitable for measuring environmental concepts acquired both in the classroom and 'holistically'. Values were assigned to each of the survey questions, and numerical indicators developed from the measuring instrument were weighted and combined to produce the AELQ.

Just as with the MSELI, a number of environmental literacy components were not able to be measured by this instrument because they would require substantial time to measure and score properly. As such, in-depth knowledge of environmental problems and issues, knowledge of alternative solutions or action strategies and some problem or issue-related skills were not assessed.

The measuring instrument (Appendix B) assessed four main domains: Knowledge, Attitude, Awareness and Action. Various strategies were used as part of the measuring instrument to explore students' environmental literacy; selected response items to assess knowledge (one item using a four-point scale, 15 multiple-choice questions, one set of true/false questions); an attitude scale (12 items based on a four-point Likert-type scale); an awareness scale (one item with a three-point ranking scale, six items with a four-point Likert-type scale and one set of items with a four-point ranking scale); and two items surveying the environmental behaviours of each student's school and home.

The questionnaire, which was completed on-line, consisted of 25 questions and took about 15 to 20 minutes to complete. The questions were made up of 66 items, of which 51 were original (developed for this research), with the remainder adapted from scales used in previous research studies.

The students were reminded that it was not a test, and that their answers were not judged as correct or incorrect. For this reason, the option of 'I don't know' was provided in the response choices. Students were also reminded that they might not have yet heard of the issues or content of the questions; another reason that 'I don't know' was a valid response.

In the development of any measure, there are a series of decisions that must be made, and the following discussion will attempt to provide the rationale behind each step of the measurement process and the numerical values assigned to the data. For the purposes of discussion, the different aspects will be split into four scales, but in the measuring instrument they were combined and not differentiated.

5.2.1 Knowledge

This scale had a maximum possible raw score of 76 and measured students' cognition of environmental concepts, some of which are covered at various Stages in the NSW Science Syllabus. Selected response items included a Likert-type scale (1-4) that varied from 'I'm sure of this' to 'I don't think so', multiple-choice, and some true/false. As not all students would have yet covered the related content they could also choose the possibility 'I don't know'.

Question 6a-e

Each of these questions asked students to rate their perception of their knowledge about a variety of key environmental issues, all of which are addressed in the NSW Science Syllabus. The responses used a Likert-type scale (1-4) that varied from 'I'm sure of this' to 'I don't think so'.

Question 10

This multiple-choice question asked students how long they estimated the world-wide supply of fossil fuels will last. Students in Stage 3 may not have covered this content in class, but this content is covered in Stages 4 and 5, as shown in Table 5.1. Each Stage

covers two years of schooling and the order in which the content is covered is left up to the school, so while a student in one school may cover this topic at the beginning of Year 7, a student in another school may cover it at the end of Year 8. It is therefore to be expected that there may be widespread discrepancies in the eco-literacy level of students within a Stage, normal variations notwithstanding.

Question 11

Question 11 is a scientific literacy multiple-choice question from the PISA measuring instrument. It was included in this study because of its overlap with content relating to ecology in the NSW Science Syllabus, as shown in Table 5.2.

Question 12

Question 12 is a multiple-choice question that directly assessed students' knowledge of food chains. The link to the NSW Science Syllabus is outlined in Table 5.3. The wording of the question is adapted from Question 18 of Alam, Jahan, Jahir and Koji's 2008 study, with slight adaptions to improve the clarity. They asked 'Which one is the producer? a. Human; b. Green plants; c. Fungi; d. Tiger'. It should be noted that due to the lack of comparable studies into environmental literacy as many common questions as possible were included, however many of the questions from this earlier study were unsuitable for use, due to their specific cultural and geographic focus, for example, 'Which is the identification sign of Arsenic polluted tube-well?'.

Question 13- 18

Questions 13 to 18 are multiple-choice questions which directly assessed students' knowledge of the composition and role of the atmosphere and the causes of climate change.

Question 14 is similar to Question 2 of Alam, Jahan, Jahir and Koji's 2008 study. They asked 'Which gas is responsible for increasing temperature of the world? a. Oxygen; b. Hydrogen; c. Carbon dioxide; d. Nitrogen'.

Table 5.1

Environmental Education Concepts in the NSW Science Syllabus – Question 10

Stage 4 Outcome 4.11 A student identifies where resources are found, and describes ways in which they are used by humans (p. 39).
4.11 natural resources A student learns to: a) distinguish between natural and made resources b) give examples of resources from living things and resources extracted from the air, Earth and oceans c) identify fossil fuels and describe some of their uses d) identify renewable and non-renewable sources of energy.
Stage 5 Outcome 5.11 A student analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources. (p. 40)
5.11.1 energy resources A student learns to: a) discuss the importance of energy as a resource b) identify properties that make some natural resources economically important and describe their uses. **5.11.2 waste from resource use** A student learns to: a) relate pollution to contamination by unwanted substances b) identify excessive use of fossil fuels as a contributing factor to a greenhouse effect c) discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality and sustainability of the environment.

Table 5.2

Environmental Education Concepts in the NSW Science Syllabus – Question 11

Stage 3 ***Living Things S3.3*** Identifies, describes and evaluates the interactions between living things and their effects on the environment.

- uses a water testing device to check the water pollution level in a local waterway and discusses findings, e.g. with an expert (p. 25).

Stage 4 Outcome 4.7 A student describes observed properties of substances using scientific models and theories. (p. 33)

4.7.5 mixtures A student learns to b) identify, using examples, the importance of water as a solvent

Outcome 4.8: A student describes features of living things. (p. 37)

4.8.1 cell theory A student learns to c) identify that substances move into and out of cells

Outcome 4.9: A student describes the dynamic structure of Earth and its relationship to other parts of our solar system and the universe. (p. 37)

4.9.5 the hydrosphere A student learns to a) describe the water cycle in terms of the physical processes involved

Table 5.3

Environmental Education Concepts in the NSW Science Syllabus – Question 12

Stage 3 ***Living Things S3.3***

Identifies, describes and evaluates the interactions between living things and their effects on the environment.

- devises a presentation for younger students on the likely impact of removing one form of life from a food chain (p. 25).

Stage 4 Outcome 4.10 A student identifies factors affecting survival of organisms in an ecosystem (p. 39).

4.10 ecosystems Students learn to b) describe, using examples of food chains and food webs from Australian ecosystems, how producers, consumers and decomposers are related

Questions 19 – 23

These multiple-choice questions assessed students' deeper understanding of the dynamics of climate change. As higher order concepts were tested, it is expected that only students with the greatest level of eco-literacy would correctly answer these questions. The questions increased in difficulty from 19 to 23.

Question 19 is adapted from Question 13 of the 2008 study, with slight modifications to improve the clarity of the wording. It asked 'Which oven does not pollute the environment? a. Solar oven; b. Kerosene oven; c. Gas oven; d. Fire wood oven'.

Question 21 is adapted from Question 3 of the 2008 study, although it asked 'Which one is the Greenhouse gas? a. Oxygen; b. Hydrogen; c. Carbon dioxide; d. Nitrogen'.

Question 22 is from adapted from Question 4 of the 2008 study, with slight modifications to improve the clarity of the wording. It asked 'What is consequence of Greenhouse effect? a. Sea-level will decrease; b. Atmosphere will be extreme cold; c. Atmosphere will be extreme hot; d. Biodiversity will increase'.

Question 23 is from adapted from Question 5 of the 2008 study, with slight changes to improve the clarity of the wording, as it asked 'What is the measure for preventing carbon dioxide increase? a. Establish oxygen plant; b. Deforestation; c. Forestation; d. Increase the use of CO2'.

Question 24

These true/false questions assessed students' understandings of the predicted impacts of climate change. The links to the NSW Science Syllabus are outlined in Table 5.4.

5.2.2 Attitude

This scale had a maximum possible raw score of 52 and measured the attitudes of students, including how important they felt environmental issues were, and how

important they felt these issues were to their family and teachers. The students' attitudes towards science and technology were also assessed.

Question 3a - c

These questions asked the students to reflect on how they felt about what they have learnt about the environment, in terms of their level of interest, how the knowledge they have gained makes them feel (i.e., their level of empowerment), and whether they remain engaged. The responses used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'.

Question 5d, e & h

These questions asked students to rank the strength of their feeling of empowerment towards environmental issues, and science and technology. The attitude scale consisted of three statements of which two indicated a positive attitude and the responses used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'.

Question 5h was taken from the USA's National Science Foundation (NSF) survey, which asked this question with almost identical wording, and measured the degree of trust the students place in science and technology to meet environmental challenges.

Question 7

This question measured the level of importance the students felt their family and teachers placed on environmental issues. Students who feel that environment and sustainability issues have a high value in both their home and school should have more positive attitudes towards action on environmental issues and potentially display higher levels of environmental literacy. The responses used a Likert-type scale (1-4) that varied from 'strongly disagree' to 'strongly agree'.

Table 5.4

Environmental Education Concepts in the NSW Science Syllabus – Question 24

Stage 3 ***Earth and its Surroundings S3.6***

Recognises that the Earth is the source of most materials and resources, and describes phenomena and processes, both natural and human, that form and change the Earth.

- researches information on the causes and effects of catastrophic events such as earthquakes and cyclones
- devises an experiment to simulate the effects of significant weather changes on flora and vegetation, e.g. extreme cold, and reports on conclusions (p. 31).

Stage 4 Outcome 4.9: A student describes the dynamic structure of Earth and its relationship to other parts of our solar system and the universe. (p. 37)

4.9.4 the atmosphere A student learns to:

a) identify gases that comprise the greater percentage of air and explain the difference between Earth's atmosphere and space

b) describe the importance of atmospheric gases, including ozone and greenhouse gases, to life on Earth.

Outcome 4.10: A student identifies factors affecting survival of organisms in an ecosystem. (p. 39)

4.10 ecosystems A student learns to d) discuss some effects of bushfires, drought and flood on Australian ecosystems.

Stage 5 Outcome 5.10: A student assesses human impacts on the interaction of biotic and abiotic features of the environment.(p. 40)

5.10 ecosystems A student learns to c) describe some impacts of human activities on ecosystems.

Outcome 5.11: A student analyses the impact of human resource use on the biosphere to evaluate methods of conserving, protecting and maintaining Earth's resources. (p. 40)

5.11.2 waste from resource use A student learns to:

a) relate pollution to contamination by unwanted substances

b) identify excessive use of fossil fuels as a contributing factor to a greenhouse effect

c) discuss strategies used to balance human activities and needs in ecosystems with conserving, protecting and maintaining the quality and sustainability of the environment.

5.2.3 Awareness

This scale had a maximum possible raw score of 76 and measured the cognitive skills of students in terms of issue identification, issue analysis and action planning. Items investigated the students' awareness of the risk posed by environmental issues, their sources of information and asked who they feel should be responsible for tackling environmental problems.

Question 2

This question asked students to self-assess their personal response to environmental and sustainability issues in terms of interest and knowledge using a three point scale (high, medium and low).

Question 3d

Question 3d was a single item which asked students to rate their perception of how much is taught at school about environmental issues. The question used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'.

Question 4

This question asked students to rank the importance of four sources of information (school and teachers, family, media and friends) in terms of their importance (lots, some, a bit, very little); but not in relation to each other.

Question 5a,b c, g & f

Questions 5a, b and c asked students to reflect on the value of individual actions vs. government and businesses while questions f, and g measured the degree of trust the students place in the science and technology to meet environmental challenges. The scale consisted of five statements of which four indicated a positive attitude and the responses used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'.

Question 25

The students were asked to rate the level of threat they feel is posed by some environmental issues, using a Likert-type scale (1-4) that varied from ‘very dangerous’, ‘somewhat dangerous’, ‘not dangerous’ to ‘I don't know’.

The questions were adapted from the National Science Foundation survey, which asked these questions with almost identical wording.

5.2.4 Action

This scale had a maximum possible raw score of 76 and measured the students’ self-assessed level of intended vs. actual behaviour, as well as their awareness of the sustainable practices carried out in their schools and homes.

Question 2c & d

This question asked students to self-assess their personal response to the need for environmental action using a three point scale (high, medium, low).

Question 8 & 9

Two items were used in the survey, one related to school practices and one to domestic practices, in order to ascertain a student’s main exposure to environmental actions. It was predicted that the number and range of practices would act as a predictor of the level of environmental literacy of the student, with those students with the highest number having the most positive attitude towards action on environmental and sustainability issues, and the greatest sense of empowerment.

Question 8 asked students to identify which of 20 environmental actions were carried out in their home, while Question 9 asked students to identify which of 17 environmentally focused activities were carried out in their school. Space was provided for additional activities to be identified by the student.

5.3 Research Sample

The students involved in this study were NSW school students in Stage 3 (Years 5 and 6), Stage 4 (Years 7 and 8) and Stage 5 (Years 9 and 10). All the students in the appropriate Stage from each school were approached, and those who returned consent forms became the selected sample. Thus ten schools and 952 students took part. Once incomplete responses were discarded (these responses were deemed unreliable and therefore unusable) 926 completed surveys remained.

Gender balanced was aimed for, with a total of 480 boys and 446 girls completing the survey. The distribution of student population is presented in Table 5.5.

5.4 School Information

Information about the schools involved is detailed below. The information was obtained during visits to the schools and via ACARA's *My School* website (http://www.myschool.edu.au).

School A

School A is a government metropolitan school, located in the upper Blue Mountains. The school has an enrolment of 306 students and an average Index of Community Socio-educational Advantage (ICSEA) of 1065 (average = 1000). School A boasts of the key role of parents in the functioning of the school, and lists its strong focus on environmental initiatives, academic excellence, and cultural diversity studies. Some of the children have parents who work in eco-tourism, while others work in the mining industry.

Table 5.5

Distribution of the Student Population

School	Stage	Number of students
A	3	19
B	3	35
C	3	29
D	3	8
E	3	2
F	4	15
F	5	16
G	4	45
G	5	24
H	4	136
H	5	174
I	4	84
I	5	167
J	4	35
J	5	137

Each year students in Year 4 attend the Brewongle Environmental Education Centre at Sackville for a three-day camp involving environmental and historical studies. Stage 2 students take part in the Streamwatch program and the Stage 3 students recently completed a 'BioBlitz' program, conducted by the Blue Mountains City Council at a local hanging swamp. The students reported learning about Aboriginal history, testing water and surveying for macro invertebrates, tree planting and learning about peat formation. On a follow up excursion a month later, students reported on their findings at a Civic Centre function, and were shown a film of their activities.

Although staff were in-serviced in 2010 in the school's Enviroplan, there is no specific focus on ESD. In 2011 School A was accepted into the Climate Clever Energy Savers program. As part of this program, Stage 3 students developed and implemented strategies to reduce energy consumption in the school.

The school collects and composts food scraps, has a kitchen garden and uses its own produce in the canteen, which is 'litterless', and uses minimal packaging (brown paper). Scrap paper is collected for recycling, and recycled paper used in worksheets. School A has water tanks and participates in Wastewatch. The pupils also take part in Streamwatch, Clean Up Australia Day, National Tree Planting Day and Walk to School Day.

The school's newsletters report on meetings of the after school Garden Club, walk-to-school 'buses', donations of local produce to the canteen, mobile phone recycling programs to raise funds to preserve mountain gorillas in the Democratic Republic of Congo, landscaping of the school's bike area and a spent battery collection point in the front office.

There is no mention of the environment in the School Annual Report, and the School Environment Management Plan (SEMP) is not available on School A's website. The school uses the Department of Education's generic 'Going Green' template to outline the purpose of SEMPs. School A does appear to have a high level of focus on environmental and sustainability issues, undertaking 10 activities from the list in the survey.

School B

School B is a government provincial school, located in the Central West of NSW. The school has an enrolment of 426 students. The school has an average ICSEA of 954. The students come from a broad range of backgrounds, with many second or third generation family members at the school. The school has an Opportunity Class program. The area has many residents employed in the coal mining, agriculture and armament industries.

School B collects scrap paper for recycling, and uses recycled paper in its worksheets. There is a kitchen garden and water tanks. The school has participated in Clean Up Australia Day, Walk to School Day, and National Tree Planting Day. Tree planting in the local area has also happened on other occasions.

There is no mention of the environment in the School Management Plan, or the Prospectus. A teacher committee wrote the SEMP, but very little has been done to implement the plan, which is not available on the school's website. School B uses the Department of Education's generic 'Going Green' template to outline the purpose of SEMPs. School B does appear to have a good awareness of environmental and sustainability issues, undertaking seven activities from the list in the survey.

School C

School C is a government metropolitan school, located in the upper Blue Mountains. The school has an enrolment of 388 students and has an average Index of Community Socio-educational Advantage (ICSEA) of 1075. School C claims to have fully embraced environmental recycling programs and energy efficient protocols, with a strong focus on positive behaviours, community involvement and participation in the arts. The school has an Opportunity Class program. The school's core values are Learning, Responsibility, Relationships and Environment.

The students used to compost foods scraps, but the program ceased with the retirement of the teacher responsible. School C reports on excursions to Longneck Lagoon ELC, The Great Aussie Bush Camp and the City Farm, its newly established kitchen garden and involvement in Clean Up Australia Day and Walk to School Day. Scrap paper is collected for recycling, and recycled paper used in worksheets and there are water tanks.

There is no mention of the environment in the School Annual Report, and the SEMP is not available on the school's website. School C uses the Department of Education's generic 'Going Green' template to outline the purpose of SEMPs. The school does

appear to have a reasonable level of focus on environmental and sustainability issues, undertaking six activities from the list in the survey.

School D

School D is a government metropolitan school, located in the upper Blue Mountains. The school has an enrolment of 154 students and an average Index of Community Socio-educational Advantage (ICSEA) of 960. There is a high incidence of poverty in this community interspersed with low to average income earners. Due to social and economic reasons there is a level of transience within the community. The main educational goals for the students are centred on the priorities of literacy, numeracy, engagement, curriculum, assessment and welfare. School D boasts of the key role of parents and volunteers in the school's functions, and lists its values of responsibility, respect, resilience, integrity and care.

The Stage 3 students recently completed the 'BioBlitz' program, conducted by the Blue Mountains City Council at a local hanging swamp, as well as taking part in Outdoor Education Week and a Bush Club excursion. The students collect and compost food scraps, there is a kitchen garden and involvement in Clean Up Australia Day, National Tree Planting Day, Walk to School Day and Wastewatch. Scrap paper is collected for recycling, and recycled paper used in worksheets. School D has water tanks and solar panels. As a community event, the school hosts the annual *Footlight* sustainability festival each year.

There is no mention of the environment in the School Management Plan or Annual Report and the SEMP is not available on the school's website. The school uses the Department of Education's generic 'Going Green' template to outline the purpose of SEMPs. School D appears to have a reasonable level of focus on environmental and sustainability issues, undertaking five activities from the list in the survey.

School E

School E is a government metropolitan school, located in the upper Blue Mountains. The school has an enrolment of 81 students and an average Index of Community Socio-educational Advantage (ICSEA) of 996. The main educational goals for the students are centred on the concepts of opportunity, achievement, nurturing and excellence. The school is an important focus of a small, close-knit community, with some parents very actively living 'alternative' lifestyles, while others are involved in the mining industry. The school has only 20 students in Stage 3, and only two responses were able to be collected, due to technical issues with internet connections following bushfire activity in the area.

The SRC recently raised funds for the Australian Conservation Council supporting the endangered black eastern quoll, and has participated in Clean Up Australia Day, and National Tree Planting Day. School E keeps chickens and has a vegetable garden. The school purchases recycled paper when the price is affordable.

There is no mention of the environment in the School Management Plan or Annual Report, and the SEMP is not available on the school's website, and the generic 'Going Green' template is used to outline the purpose of SEMPs. School E appears to have a high level of focus on environmental and sustainability issues, undertaking nine activities from the list in the survey.

School F

School F is a government provincial high school, located in the Central West of NSW. The school has an enrolment of 864 students and an average ICSEA of 946. The students come from a broad range of backgrounds, with many the second or third generation family members at the school. School F has gifted and talented students' programs and a strong focus on sport and the performing arts. The school also has programs to improve the poor education outcomes of some students. The area has many residents employed in the coal mining, agriculture and armament industries.

School F has a farm, and grows fodder crops and vegetables as well as raising chickens, pigs and sheep. Year 7 study a permaculture course for a semester. The school used a $50,000 grant to install water tanks which are used in a sprinkler system for the farm and playing fields. Another $50,000 grant was used to install solar panels, which are monitored for reductions in CO_2 emissions. Food scraps are composted, and the school participates in National Tree Planting Day, as well as Walk/Bike to School Day. Additionally, School F has installed dual flush toilets and worm farms.

There is no mention of the environment in the School Annual Report or the Prospectus. The SEMP is not available on the school's website. School F uses the Department of Education's generic 'Going Green' template to outline the purpose of SEMPs. The school appears to have a good level of awareness of environmental and sustainability issues, undertaking seven activities from the list in the survey.

School G

School G is a government metropolitan high school, located in the lower Blue Mountains of NSW. The school has an enrolment of 984 students and an average ICSEA of 1053. This comprehensive school has a strong academic reputation with first in state in a number of HSC courses, numerous Premier's Awards for HSC excellence, band and dance programs. School G aims to provide a balanced and challenging curriculum which caters for all.

As part of the National Solar Schools program the school has recently installed a 7kW solar panel system. The Sunnyportal system allows the power generation and usage patterns of the school to be tracked. This has the potential of allowing the students to track data and take an active role in reducing the school's electricity usage.

The school's Environmental Management Plan (posted on the school website) was developed in 2011 and ran until 2012. An Environment Group was founded in 2009, and a recycling system for paper and recycling bins in the grounds, as well as turning off the water in the urinals and using waterless urinal biological agents to maintain toilet

hygiene, had previously been achieved. The aims of the SEMP included increasing student engagement in environmental activities through student centred projects, extending EE opportunities by increasing the use of the existing outdoor learning spaces and incorporating sustainability and waste reduction across the curriculum. School G aimed to use less electricity and water, create less waste, to increase the biodiversity of plant and animal life in the schools grounds and to apply for grants in order to install solar panels. Practical measures were to include composting, a food garden, water tanks, water filters and bottle refilling stations, water and energy efficiencies.

There is no mention of the environment in the most recent School Annual Report, or the Prospectus. School G appears to have a reasonable level of focus on environmental and sustainability issues, undertaking five activities from the list in the survey.

Data collection at this school was interrupted by bushfire activity in the area and was collected on two occasions, separated by some 12 weeks.

School H

School H is a comprehensive provincial high school 200 km west of Sydney. The school has an enrolment of 810 students and an average Index of Community Socio-educational Advantage (ICSEA) of 943. The school is one of two government high schools in the city, and is regarded as drawing students from the lower end of the socio-economic spectrum. The school is recognised for its focus on strong academic and vocational education, creative and performing arts and language programs.

School H has a farm, an indigenous food garden and a wetlands area. An Environment Team works to propagate native plants for environmental projects and in the Clean Up Australia program. They also monitor the school recycling program.

The school's Waterwatch program monitors local waterways and works with the Catchment Management Authority to test water at five sites and macro invertebrate surveys at two sites. The students involved in this program have also mentored year 6 students by teaching them about pond ecosystems at the school's Boona Wetlands.

There is mention of the environment in the 2011 and 2010 Annual Reports, but the SEMP is not available on the school's website, and the generic 'Going Green' template is used to outline the purpose of SEMPs. Nonetheless, the school appears to have a high focus on environmental and sustainability issues, undertaking ten activities from the list in the survey.

School I

School I is a comprehensive provincial high school 200 km west of Sydney. The school has an enrolment of 869 students and an average Index of Community Socio-educational Advantage (ICSEA) of 975. The school is one of two government high schools in the city, and is regarded as drawing students from the higher end of the socio-economic spectrum. A diverse range of sporting, cultural, vocational and academic opportunities are offered to students and the school is recognised for the excellence of its academic and vocational curricula.

The school has a farm, including fish in aquaculture tanks. School I has a long tradition of involvement in the animal nursery each year at the Royal Easter Show. Food scraps from the canteen are used at the farm and the agriculture plot also has water tanks. The school participates in National Tree Planting Day, as well as Clean Up Australia Day and has taken part in Solar Car racing challenges.

There is no mention of the environment in the Annual Report, the SEMP is not available on the school's website, and the generic 'Going Green' template is used to outline the purpose of school environmental management plans. School I appears to have a high level of focus on environmental and sustainability issues, undertaking nine activities from the list in the survey.

School J

School J is a comprehensive provincial high school 250 km west of Sydney. The school has an enrolment of 1000 students and an average Index of Community Socio-educational Advantage (ICSEA) of 967. The school is one of two government high

schools in the city, and is regarded as drawing students from the higher end of the socio-economic spectrum. The school is recognised for its achievements in academia, sport, creative and performing arts and student leadership.

School J has a farm, including an indigenous food garden and a vineyard. Food scraps from the canteen are used at the farm, and the school has water tanks. The school has participated in Clean Up Australia Day in some years. School J has purchased recycled paper when the price is affordable, but their current photocopy machine is not compatible with recycled paper.

There is no mention of the environment in the Annual Report, the SEMP is not available on the school's website, and the generic 'Going Green' template is used to outline the purpose of SEMPs. School J appears to have a reasonable level of focus on environmental and sustainability issues, undertaking six activities from the list in the survey.

5.5 Data Collection

All of the public schools in the author's locality were approached and asked to participate in the survey. Although some declined immediately, most were very willing to assist. Two schools agreed to participate, but then were unable to schedule any time for data collection. Parental Consent Forms (see Appendix B) were issued, and if a parent or guardian completed, signed, and returned this form students were able to participate in the survey.

The author was introduced to the students and she then gave the same scripted explanation in which she explained to the students the purpose of the survey. The students were informed of the importance of their views to improve EfS, that they may not have studied some of the concepts assessed in the measuring instrument and that 'I don't know' was a valid response, as well as the difference between questions requiring their opinions and those involving objective knowledge. The students' anonymity was stressed, as well as the fact that the survey was not a test, and that there was no mark involved.

The author remained in the classroom to assist with logging onto the survey, and to answer any questions which arose. The teachers also remained in the classroom to help maintain classroom order. Students whose parents declined permission, were given an alternate activity. In general, the survey was able to be administered and completed within less than a standard classroom period and the vast majority of students completed the survey without skipping questions or making a non-serious attempt.

The survey was conducted using Survey Monkey. The data were entered into an Excel spread sheet and assigned numerical values prior to analysis.

In a small number of instances the Survey Monkey website crashed, or did not save the students' responses. These partially completed surveys were discarded. Approximately 20 students, mostly in Stage 5, did not complete the survey, usually at the point where they did not have to complete a question in order to move onto the next (i.e., at Question 8 or 9). These partially completed surveys were also discarded, as they were not able to be used to provide a full set of responses for any of the four scales, and were not considered to be valid or reliable.

5.6 Assigning Numeric Values to the Data

The analysis of the data aimed to define the links between the students' actions for, and attitudes towards, the environment; as well as their awareness of the issues and understanding of the related concepts. The four dimensions of environmental literacy were combined to provide a single estimate of the level of environmental literacy. Conceptually, individuals who demonstrated a positive level in the *Attitude* and *Action* dimensions would be expected to be the most capable of acquiring and comprehending information about environmental issues, thus scoring highly in the *Awareness* and *Knowledg*e scales.

Individuals who score highly across the four scales, and thus in the combined score, will have *highly evolved* environmental literacy. Students who demonstrate either an adequate vocabulary of environmental constructs or an acceptable level of understanding of the nature of sustainability issues will have *functional* environmental literacy. These students would be expected to be relatively more capable of receiving and utilizing

information about an environmental issue than students who do not understand the content or context, or do not have a positive attitude towards the environment. This third group will be referred to as *nominally* environmentally literate. Students who display very little understanding of environmental issues, and who demonstrate little in the way of positive values, attitudes or behaviours towards environmental issues will be referred to as *environmentally illiterate*.

As this measuring instrument represents one of the first attempts to measure the environmental literacy of Australian students, it was difficult to predict what results might reasonably be expected and, as such, data analysis could not begin until a large sample of data had been collected. Provisional numerical values were assigned to the ordinal scale in the initial stages of data analysis, and the rationale for this procedure is outlined below.

The assignment of numerical values to the ordinal scale was done with the aim that the students with the highest level of environmental literacy should rate their level of interest, and action most highly, in addition to scoring highly in the knowledge and awareness scales of the survey.

Question 2

This question asked students to self-assess their personal response to environmental and sustainability issues in the areas of interest, knowledge and action using a three point scale (high = 3, medium = 2, low = 1).

Question 3

These responses used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'. Students with the highest level of environmental literacy should also be most aware of sustainability issues being taught and discussed at their school and have the highest level of interest and empowerment. The ordinal scale was converted to a numerical equivalent and the values that were assigned are outlined in Table 5.6.

Question 4

This question asked students to rank the importance of four sources of information in terms of their importance, but not in relation to each other. The ordinal scale was converted to numerical equivalent in order to allow a judgment to be made about where students feel they obtain their environmental information (school vs. non-school). The numerical values assigned were: lots = 4, some = 3, a bit = 2, very little = 1.

Question 5

This attitude scale consisted of statements of which seven indicated a positive attitude; and the responses used a Likert-type scale (1-4) that varied from 'strongly agree' to 'strongly disagree'. The ordinal scale was converted to a numerical equivalent, as outlined in Table 5.7.

Question 6a-e

These responses used a Likert-type scale (1-4) that varied from 'I'm sure of this' to 'I don't think so'. The ordinal scale was converted to a numerical equivalent, so that 'I'm sure of this' scored four, and 'I don't think so' scored one. The scoring was reversed for question 6g.

The highest scores were thus assigned to the students with the highest level of environmental knowledge.

Table 5.6

Numerical Values Assigned to Question 3

Question 3 a, b, c	
Response	Value
strongly agree	4
agree	3
disagree	2
strongly disagree	1
Question 3d	
Response	Value
strongly agree	1
agree	2
disagree	3
strongly disagree	4

Table 5.7

Numerical Values Assigned to Question 5

Question 5 a, b, c, d, e, g	
Response	Value
strongly agree	4
agree	3
disagree	2
strongly disagree	1
Question 5 f, h	
Response	Value
strongly agree	1
agree	2
disagree	3
strongly disagree	4

Question 7

These responses used a Likert-type scale (1-4) that varied from 'strongly disagree' to 'strongly agree'. The ordinal scale was converted to a numerical equivalent, so that 'strongly disagree' scored one, and 'strongly agree' scored four. Students who felt that environmental and sustainability issues were given a high value in both their home and school should have more positive attitudes towards action on environmental issues and potentially display higher levels of environmental literacy.

Question 8 & 9

Two items were used in the survey, one related to school practices and one to domestic practices in order to ascertain where a student's main exposure to environmental actions lay. It was decided that the number and range of activities should act as a predictor of the level of environmental literacy of the student. Those students whose families undertook the highest number of activities should have the most positive attitudes towards action on environmental and sustainability issues, and the greatest sense of empowerment.

Question 8 asked students to identify which of 20 environmental actions were carried out in their home, while Question 9 asked students to identify which of 17 environmentally focused activities were carried out in their school. Each activity was assigned a single point; thus the number of activities in the home had a potential maximum score of 20. The activities carried out by the school were assigned a point if correctly identified by the student, and the raw score converted to a score out of 20, so that equal weight was given to the environmental activities in both domains.

Questions 10-23

The thirteen multiple-choice questions were scored similarly. The correct response was given a value of two, incorrect responses were given a value of one, while 'I don't know' was assigned a value of zero. It was decided that students who had an incorrect

perception had a higher level of environmental literacy than those who did not know at all.

Question 24

For these true/false questions the correct response was given a value of two, incorrect responses were given a value of one, while ‘I don’t know’ was assigned a value of zero. It was decided that students who had incorrect knowledge had a higher level of environmental literacy than those who did not know at all.

Question 25

The students were asked to rate the level of threat they felt was posed by some environmental issues, using a Likert-type scale (1-4) that varied from ‘very dangerous’, ‘somewhat dangerous’, ‘not dangerous’ to ‘I don't know’. The ordinal scale was converted to a numerical equivalent where the most reasonable response was given a value of three. Students who chose ‘I don’t know’ were assigned a value of zero.

As a result of assigning these values to each student response, the analysis of the data could begin. The four scales of environmental literacy had raw values as outlined in Table 5.9.

Table 5.8

Numerical Values Assigned to Question 25

Question 25 a, b, f	
Response	Value
very dangerous	2
somewhat dangerous	3
not dangerous	1
I don't know	0
Question 25 c, d, e	
Response	Value
very dangerous	3
somewhat dangerous	2
not dangerous	1
I don't know	0

Table 5.9

Raw Values for the Component Scales

Aspect of Environmental Literacy	**Raw Value**
Knowledge	76
Attitude	48
Awareness	67
Action	46
Total	237

CHAPTER 6

RESULTS & DISCUSSION

6.1 Introduction

This thesis examined five research questions:

Research Question One asked: Are *the current NSW Science syllabuses and educational policy documents supporting the development of environmental literacy in NSW students?* This question will be addressed in Section 6.5 where the responses of students are linked to the syllabus content, and in the discussion of the findings of the survey, in Section 6.6.

Research Question Two asked: *How is environmental literacy to be defined and measured?* The definition of environmental literacy was addressed in Chapter 4 and the development of the measuring instrument in Section 5.2.

Research Question Three asked: *What are the measurable levels of environmental literacy in NSW students in Stage 3 to 5 for each of the variables knowledge, attitude, awareness and action*? This is discussed in Sections 6.2 and 6.3. Section 6.2 outlines the descriptive results of the survey data, while Section 6.3 examines the frequency distributions of the responses.

Research Question Four asked: *Do the sustainability practices of the school contribute to the values and attitudes of students towards environmental issues?*. Correlations between the survey responses of students and the sustainability practices at their school are examined in Section 6.4.

Research Question Five asked: *Do the sustainability practices in the home have a greater influence on the values and attitudes towards environmental issues than the practices at the student's school?*. Correlations between the survey scores of students and the sustainability practices of their family are examined in Section 6.4.

In summary, in Section 6.2 the descriptive results of the study are presented, arranged under the four scales measured; knowledge, attitude, awareness and action. Section 6.3 outlines the frequency distribution of the survey responses and in Section 6.4 the correlations between these dimensions are described, along with the analysis of any relationships between these four factors. Section 6.5 examines the results for each stage in terms of the syllabus content covered in order to determine if environmental knowledge develops in students over time. Section 6.6 discusses how the data from the survey can be aligned with the descriptive Scale of Environmental Literacy, and finally, Section 6.7 presents reflections on the method and the limitations and shortcomings of the method.

6.2 Descriptive Results of the Survey, by Scale

6.2.1 A Summary and Overview of the Findings of the Survey

The simplest way to report the results from this environmental literacy assessment is in the form of descriptive statistics for the entire sample for each Stage. The results of these analyses of aggregated Stage 3, 4 and 5 scores are summarized in Table 6.1.

On the cognitive scales, student scores were, on average, higher on the Awareness Scale (Stage 3 = 70.4%; Stage 4 = 67.1%; Stage 5 = 67.5%) than on the Knowledge Scale (Stage 3 = 56.0%; Stage 4 =58.7%; Stage 5 = 62.2%), suggesting students were more aware of, than equipped with, knowledge about environmental and sustainability issues.

In terms of simple comparisons between Stage 3, 4 and 5, on average Stage 5 students scored very slightly higher than Stage 3 and 4 students on the Knowledge Scale, while Stage 3 scored higher than Stages 4 and 5 on the Awareness Scale. While the differences are relatively small, they suggest that Stage 5 students are more knowledgeable, but that high students are less aware than students in primary school of environmental and sustainability issues.

Similarly, on the action-orientated scales, student scores were, on average, higher on the Attitude Scale (Stage 3 = 76.4%; Stage 4 = 66.7%; Stage 5 = 65.3%) than on the Action

Scale (Stage 3 = 61.0%; Stage 4 = 50.7%; Stage 5 = 48.3%), indicating that their intentions were more positive than the sum of their actions.

Table 6.1

Summary of Descriptive Statistics for Weighted Data, by Scale

Stage	n	Range	Mean	SD	Median	Mode
Knowledge Scale						
3	93	60	56.0	14.8	55	50
4	315	82	58.7	14.9	61	66
5	518	82	62.2	15.5	65	80
Attitude Scale						
3	93	34	76.4	8.3	77	77
4	315	52	66.7	10.0	67	71
5	518	63	65.3	10.5	67	69
Awareness Scale						
3	93	50	70.4	9.3	72	79
4	315	59	67.1	11.4	70	67
5	518	69	67.5	11.7	70	73
Action Scale						
3	91*	79	61.0	14.1	60	55
4	288*	71	50.7	15.0	50	48
5	457*	71	48.3	14.0	48	48

*Note: Students who did not answer question 8 or 9 were removed from the analysis

If comparisons are made between Stages 3, 4 and 5, on average Stage 5 students scored lower than Stage 3 and 4 students on the Attitude Scale and on the Action Scale. These differences suggest that Stage 5 students have a less positive attitude towards understanding and tackling environmental and sustainability issues, and are less likely to take action. Neither of these scoring patterns contradicts intuitive assumptions about measures in environmental education.

6.2.2 Descriptive Findings for the Knowledge Component

The unweighted results for the 31-item measure of ecological knowledge are presented in Table 6.2. These results indicate that the mean score for Stage 5 (X = 47.3, or 62.2%) was slightly greater than for Stage 4 (X = 44.6, or 58.7%) and Stage 3 (X = 41.7, or 56.0%). In all three samples, the standard deviation was around 11, indicating that these scores varied substantially among students in each sample. Additionally, in the Stage 4 and 5 samples the mean was slightly lower than the median and mode, indicating that the distribution of scores for this sample was slightly negatively skewed, while the Stage 3 sample was the most normally distributed.

Table 6.2

Descriptive Results of Knowledge Component by Stage, Unweighted Data

	Stage 3	**Stage 4**	**Stage 5**
n	93	315	518
Mean*	41.7	44.6	47.3
SD	11.5	11.3	11.8
Median*	42	46	49
Mode*	38	50	53
Highest Score	66	68	69
Lowest Score	17	10	10

*Note: Possible Points = 76

6.2.3 Descriptive Findings for the Attitude Component

The results for the seven-item measure of values and attitudes are presented in Table 6.3. These results indicate that the mean score for Stage 3 (X = 36.9, or 76.4%) was greater than for both Stage 4 students (X = 32.0, or 66.7%) and Stage 5 students (X = 31.4, or 65.3%). For all samples, the standard deviation was between 3.7 and 5.1, indicating that the scores did not vary substantially among students, while the congruence between the mean, median and mode scores indicates that, for this component, the scores in each sample are nearly normally distributed.

Table 6.3

Descriptive Results of Attitude Component by Stage, Unweighted Data

	Stage 3	**Stage 4**	**Stage 5**
n	93	315	518
Mean*	36.9	32.0	31.4
SD	3.7	4.8	5.1
Median*	37	32	32
Mode*	37	34	33
Highest Score	43	44	45
Lowest Score	28	19	15

*Note: Possible Points = 48

6.2.4 Descriptive Findings for the Awareness Component

The results for the 12-item measure of cognitive skills (issue identification and issue analysis) are shown in Table 6.4. These results indicate that the mean score for Stage 3 (X = 47.7, or 70.4%) was greater than for Stage 4 (X = 45.0, or 67.1%) and Stage 5 (X = 45.3, or 67.5%). For these samples, the standard deviation was between 6 and 8, indicating some variations among students in each sample. The median and mode for all

three stages were higher than the mean, indicating that the results were negatively skewed.

Table 6.4

Descriptive Results of Awareness Component by Stage, Unweighted Data

	Stage 3	**Stage 4**	**Stage 5**
n	93	315	518
Mean*	47.7	45.0	45.3
SD	6.1	7.6	7.8
Median*	49	47	47
Mode*	54	45	49
Highest Score	60	58	61
Lowest Score	27	19	15

*Note: Possible Points = 67

6.2.5 Descriptive Findings for the Action Component

The results for the two-item measure of participating in responsible environmental behaviours are presented in Table 6.5. These results indicate that the mean score for Stage 3 students (X = 26.0, or 61.0%) was slightly higher than for Stage 4 students (X = 23.3, or 50.7%) and Stage 5 students (X = 22.2, or 48.3%). The standard deviation for each sample was around 6.5 indicating some variation among students in each sample, but the mean and median scores nearly equivalent, indicating that the scores for these samples were about normally distributed.

Table 6.5

Descriptive Results of Action Component by Stage, Unweighted Data

	Stage 3	**Stage 4**	**Stage 5**
n**	91	288	457
Mean*	26.0	23.3	22.2
SD	6.6	6.9	6.4
Median*	26	23	22
Mode*	22	22	22
Highest Score	41	40	40
Lowest Score	11	6	7

*Note: Possible Points = 46

**Students who did not complete questions 8 or 9 were removed from the analysis.

6.3 Frequency Distribution of Responses, by Scale of the AELQ

The results of one additional set of exploratory analyses are reported in this section. These analyses included:

- the frequency of correct and incorrect responses for each item in the cognitive Knowledge and Awareness Scales (i.e., the percentage of correct responses), used to calculate item difficulty; and
- the frequency of response for each item in the non-cognitive scales (i.e., Attitude and Action Scales) to gain some insight into overall response patterns to affective and behavioural items.

These results are summarized in the following four sub-sections.

6.3.1 Item Difficulty Results and Frequency Distribution of Responses for the Knowledge Scale

Table 6.6 demonstrates the level of item difficulty for each of the 31 items in this scale for each stage, in the form of decimals. Item difficulty values can range from 0% (i.e., no student responds correctly) to 100% (i.e., all students respond correctly). The items are ranked by degree of difficulty for each stage, where 1 represents the easiest (i.e. most correctly answered) question. In the case of question 6a–g two of the possible responses were counted as correct in this analysis ('I'm sure of this' and 'I think so, but I'm not 100% sure').

Stage 3

For the Stage 3 sample, item difficulties ranged from a low of 2.2% (question 16) to a high of 90.1% (question 6a). There were eight items (questions 10c, 13, 15, 16, 18, 20, 21 and 23) that would be considered very difficult (i.e., 20% or below). Fewer than 10% of students were able to correctly answer questions involved specific technical knowledge of environmental issues; almost certainly referring to content they had not studied:

13 What percentage of the volume of the Earth's atmosphere is carbon dioxide?

21 Which of these gases is NOT a greenhouse gas?

20 About how many tons of carbon dioxide does the activities of the average Australian emit each year?

16 According to data collected by climate scientists, how many of the ten hottest years on record have occurred in the past 10 years?

Twelve items had an item difficulty below 50% (questions 6g, 10a, 10b, 11, 12, 14, 17, 22, 24c, 24e, 24f and 24g). Only two items (questions 6a and 6c) would be considered very easy (i.e., 80% or higher), and over 80% of Stage 3 students were able to correctly

identify that the planet is becoming warmer and the climate is changing; that the extinction of one species has an impact on other species; and that human activity is the main reason for climate change.

Five items had a level of difficulty between 50% and 65%, which tended to spread out the distribution and provided a more accurate picture of the percentage of students who have mastered the ecological and environmental concepts in these items. These items (questions 6f, 19, 24a, 24d, and 24h) are ranked from 7th to 11th in the Stage 3 column of Table 6.6.

Stage 4

For the Stage 4 sample, item difficulties ranged from a low of 8.9% (question 16) to a high of 89.5% (question 6a). There were six items (questions 13, 16, 18, 20, 21 and 23) that would be considered very difficult (i.e., 20% or below). Fewer than 10% of students were able to correctly answer questions 16 and 20.

Thirteen items had an item difficulty below 50% (questions 6g, 6f, 10a, 10b, 10c, 11, 12, 15, 17, 22, 24e, 24g and 24h). Only two items (questions 6a and 6c) would be considered very easy (i.e., 85% or higher), with over 80% of Stage 4 students were able to correctly identify that the planet is becoming warmer and the climate is changing; that the extinction of one species has an impact on other species; and that the burning of fossil fuels is the main source of greenhouse gases.

Six items had a level of difficulty between 50% and 65%, which has the benefits described above. These items (questions 14, 19, 24a, 24c, 24f and 24h) are ranked 8th to 13th in the Stage 4 column of Table 6.6.

Stage 5

For the Stage 5 sample, item difficulties ranged from a low of 9.8% (question 16) to a high of 90.5% (question 6c). There were five items (questions 13, 16, 18, 20 and 21) that would be considered very difficult (i.e., 20% or below). Fewer than 10% of students were able to correctly answer question 16.

Twelve items had an item difficulty below 50% (questions 6f, 6g, 10a, 10b, 10c, 11, 12, 15, 17, 23, 24e and 24g). Only two items (questions 6a and 6c) would be considered very easy (i.e., 85% or higher), with over 80% of Stage 5 students were able to correctly identify that the extinction of one species has an impact on other species; that the planet is becoming warmer and the climate is changing; that the burning of fossil fuels is the main source of greenhouse gases; and that human activity is the main reason for climate change.

Six items had a level of difficulty between 50% and 65%, which has the benefits already described. These items (questions 14, 19, 22, 24c, 24f and 24h) are ranked 9th to 14th in the Stage 5 column of Table 6.6.

Table 6.6

Level of Item Difficulty of Items in Knowledge Scale

Item #	**Stage**	**n**	**Item % correct**	**Difficulty Stage 3**	**Difficulty Stage 4**	**Difficulty Stage 5**
6a	3	93	90.1			
	4	315	89.5	1	1	2
	5	518	89.2			
6b	3	93	79.1			
	4	315	76.2	3	4	3
	5	518	79.7			
6c	3	93	89.0			
	4	315	85.1	2	2	1
	5	518	90.3			
6d	3	93	70.3			
	4	315	72.4	6	5	4
	5	518	81.9			

Item #	Stage	n	Item % correct	Difficulty Stage 3	Difficulty Stage 4	Difficulty Stage 5
6e	3	93	78.0			
	4	315	77.5	4	3	5
	5	518	78.2			
6f	3	93	56.0			
	4	315	35.6	9	20	21
	5	518	41.7			
6g	3	93	29.7			
	4	315	38.4	21	19	15
	5	518	49.4			
10a	3	93	45.1			
	4	315	42.9	15	17	16
	5	518	46.3			
10b	3	93	31.9			
	4	315	42.2	18	18	19
	5	518	44.2			
10c	3	93	18.7			
	4	315	29.8	25	23	24
	5	518	32.6			
11	3	93	30.8			
	4	315	44.1	19	15	17
	5	518	46.1			
12	3	93	24.2			
	4	315	31.4	23	21	18
	5	518	45.2			

Item #	Stage	n	Item % correct	Difficulty Stage 3	Difficulty Stage 4	Difficulty Stage 5
13	3	93	9.9			
	4	315	11.7	28	28	28
	5	518	14.5			
14	3	93	47.3			
	4	315	55.9	13	10	9
	5	518	64.9			
15	3	93	16.5			
	4	315	22.6	26	25	25
	5	518	30.7			
16	3	93	2.2			
	4	315	8.9	31	31	31
	5	518	9.8			
17	3	93	37.4			
	4	315	43.8	16	16	22
	5	518	40.9			
18	3	39*	15.4			
	4	315	13.0	27	27	30
	5	518	11.6			
19	3	93	49.5			
	4	315	60.0	11	9	12
	5	518	58.5			
20	3	93	5.5			
	4	315	9.8	30	30	29
	5	518	12.0			

Item #	Stage	n	Item % correct	Difficulty Stage 3	Difficulty Stage 4	Difficulty Stage 5
21	3	93	7.7			
	4	315	10.2	29	29	27
	5	518	17.6			
22	3	93	36.3			
	4	315	48.6	17	14	13
	5	518	56.9			
23	3	93	19.8			
	4	315	16.5	24	26	26
	5	518	25.1			
24a	3	93	58.2			
	4	315	65.4	8	8	8
	5	518	68.1			
24b	3	93	71.4			
	4	315	67.0	5	7	6
	5	518	72.4			
24c	3	93	46.2			
	4	315	50.8	14	12	11
	5	518	59.1			
24d	3	93	63.7			
	4	315	67.9	7	6	6
	5	518	72.4			
24e	3	93	30.8			
	4	315	31.4	19	21	20
	5	518	42.9			

Item #	Stage	n	Item % correct	Difficulty Stage 3	Difficulty Stage 4	Difficulty Stage 5
24f	3	93	48.4			
	4	315	51.7	12	11	10
	5	518	62.4			
24g	3	93	28.6			
	4	315	29.8	22	23	23
	5	518	35.7			
24h	3	93	54.9			
	4	315	49.5	10	13	14
	5	518	55.0			

*Note: Question 18 added after the first two schools were surveyed

6.3.2 Summary for Knowledge Scale

The most striking thing about these results is just how similar they are for each of the three stages. Three items ranked exactly the same for all stages, and the relative ranks were not more than three places apart for 24 items. There were only four questions where Stage 5 students found the questions considerably easier (questions 6g, 12, 14 and 22); and two where Stage 5 students found the question slightly easier (questions 6d and 24c) than Stages 3 and 4. There were actually two questions that Stage 3 students found significantly easier than either Stage 4 or 5 students (questions 6f and 24h); and one that Stage 3 and 4 students equally found easier than Stage 5 students (question 17).

However, the difference in the levels of item difficulty between the stages exceeded five percent in 22 items (questions 6d, 6f, 6g, 10b, 10c, 11, 12, 14, 15, 16, 17, 19, 20, 21, 22, 23, 24a, 24c, 24d, 24e, 24f and 24g) suggesting that although the same questions were difficult for all stages, there were differences in the percentage of students in each stage able to answer them correctly. As would be expected, in the majority of questions Stage 3 found the questions more difficult than Stage 4 and 5, respectively. In the majority of

these questions (questions 6d, 6f, 6g, 10b, 10c, 11, 12, 14, 15, 19, 22, 24c, 24e and 24f), the difference was 10% or more. In two questions (questions 12 and 22), greater than 20% more Stage 5 students were able to correctly identify a producer, and a likely consequence of climate change.

However, this did not occur in all cases, and Stage 3 students were more likely to answer questions 6f (there are more people living in Australia than our environment can handle) and 18 (which country has the highest emissions of greenhouse gases per head of population) correctly than either Stage 4 or 5. Stage 4 students were more likely to answer questions 17 (which country emits the greatest volume of carbon dioxide from human activities) and 19 (which method of cooking does not pollute the environment) correctly, yet less likely to correctly answer questions 6b, 6c, 10a, 18, 23, 24b and 24h than younger students (human activity is the main reason for climate change; the extinction of one species has an impact on other species; how long the world-wide supply of coal will last; which country has the highest emissions of greenhouse gases per head of population; which of these measure would reduce the levels of greenhouse gases in the atmosphere; is Australia's weather likely to change; and will plants and animals be able to quickly adapt to changes in their environment).

6.3.3 Frequency Distribution of Responses for the Attitude Scale

Reporting the frequency distribution of responses is appropriate for items that measure attitudes, actions and behaviour, particularly when the response scale for such items is ordinal in nature. The items in this scale were designed to measure students' verbal commitment or intentions to act (i.e., affective predispositions toward behaviours), and the response scale was a modified Likert-type scale. Consequently, the frequency distribution of responses for each item is reported in the form of percentages for each Stage in Table 6.7.

The results were broadly consistent across the three stages, and for seven items (questions 3a, 3b, 3c, 5d, 5e, 7b and 7c) the majority of students in all three stages agreed with the statements.

There were two items (questions 3c and 5d) where a majority of students in Stage 3 indicated a more positive attitude, with the majority choosing ‘strongly agree’, whereas the majority of students in Stages 4 and 5 chose ‘agree’:

> What I learn makes me think I can help protect and preserve the planet.
>
> I would like to do as much as I can to help the environment.

In two items (questions 7a and 7d) the majority of high school students disagreed with the statements, while primary school students tended to agree:

> At my school we talk about sustainability issues and the environment a lot.
>
> In my family we talk about sustainability issues and the environment a lot.

For every item in this scale, Stage 3 students responded more positively, outscoring Stage 4 and 5 students in terms of positive responses. This is particularly striking in response to the statement ‘I am interested in what I learn about the environment in class’ (question 3a), where 98.9% of Stage 3 students chose either ‘strongly agree’ or ‘agree’; a more strongly positive response than either Stages 4 or 5 (77.4% and 73.0%, respectively); and for the statement ‘What I learn makes me think I can help protect and preserve the planet’ (question 3c), where 94.7% of Stage 3 students responded positively, compared to only 65.1 and 65.2% of students in Stages 4 and 5, respectively. Furthermore, a majority of students in Stage 3 chose ‘strongly agree’, whereas the majority of students in Stages 4 and 5 chose ‘agree’.

Stage 3 students were almost evenly split over the statement ‘In my family we talk about sustainability issues and the environment a lot’ (question 7d) with 54.8% of students agreeing, but a majority of students in Stages 4 and 5 disagreed with this statement (72.7 and 76.3%, respectively). A clear majority (76.3%) of Stage 3 students agreed with the statement ‘My parents are concerned about the future of the environment’ (question 7e), while only 51.6% of Stage 5 students felt this way, and 50.5% of Stage 4 students actually disagreed with the statement. A strong majority (80.6%) of Stage 3 students agreed with the statement ‘It matters to my parents that I understand environmental

issues' (question 7f), while only 59.0% of Stage 4 students felt this way. A slight majority of Stage 5 students (51.5%) did not agree with this statement.

In only one item (question 7f) was the difference between Stages 4 and 5 for the combined response to 'strongly agree' and 'agree' more than 4 percentage points, but in all questions the difference between the level of positive response for Stage 3 and for Stages 4 and 5 was greater than 10 percent and as high as 30 percent.

In question 5h, the majority of Stage 3 and 5 students (60.2% and 51.3%, respectively) agreed with the statement 'Science and technology makes our way of life change too fast', but 51.4% of Stage 4 students disagreed.

6.3.4 Summary for Attitude Scale

For most items students tended to display positive attitudes towards the environment, in that they felt that they understood that the issues were important and of concern, and that they understood what types of action need to be taken. In all items, Stage 3 students responded more positively than students in Stages 4 and 5, although the famous cynicism of teenagers might account for their less positive responses, including their feeling that science and technology change things too quickly. Nonetheless, the majority still reported strong levels of interest in learning about environmental issues, even if they felt less empowered by what they learn than primary aged students. High school students felt that sustainability issues were not talked about a lot at home or at school, and they also felt their parents cared less about such issues.

Table 6.7

Frequency Distribution of Responses, as Percentages and by Stage, for Attitude Scale

Stage	N	Strongly agree %	Agree %	Disagree %	Strongly disagree %	Combined positive %	Combined negative %
Question 3a I am interested in what I learn about the environment in class							
3	93	44.1	**54.8***	1.1	0.0	**98.9**	1.1
4	315	15.2	**62.2**	17.5	5.1	**77.4**	22.6
5	518	12.0	**61.0**	23.4	3.7	**73.0**	27.0
Question 3b The things I learn make me worry about the future of the planet							
3	93	36.6	**47.3**	16.1	0.0	**83.9**	16.1
4	315	30.5	**43.8**	21.0	4.8	**74.3**	25.8
5	518	24.3	**53.9**	18.1	3.7	**78.2**	21.8
Question 3c What I learn makes me think I can help protect and preserve the planet							
3	93	**49.5**	45.2	4.3	1.1	**94.7**	5.4
4	315	15.6	**49.5**	29.8	5.1	**65.1**	34.9
5	518	10.0	**55.2**	29.0	5.8	**65.2**	34.8
Question 5d I would like to do as much as I can to help the environment							
3	93	**69.9**	29.0	1.1	0.0	**98.9**	1.1
4	315	26.3	**54.0**	14.6	5.1	**80.3**	19.7
5	518	15.6	**63.1**	17.2	4.1	**78.7**	21.3
Question 5e I understand the sorts of things I can do in my day-to-day activities to help the environment							
3	93	39.8	**53.8**	5.4	1.1	**93.6**	6.5
4	315	19.0	**61.6**	16.2	3.2	**80.6**	19.4
5	518	14.5	**64.9**	18.1	2.5	**79.4**	20.6
Question 5h Science and technology makes our way of life change too fast**							
3	93	22.6	**37.6**	35.5	4.3	**60.2**	39.8
4	315	15.2	33.3	**41.9**	9.5	48.5	**51.4**
5	518	13.3	38.2	**39.6**	8.9	**51.3**	48.5
Question 7a At my school we talk about sustainability issues and the environment a lot							
3	93	4.3	**58.1**	35.5	2.2	**62.4**	37.7
4	315	3.8	41.0	**45.4**	9.8	44.8	**55.2**
5	518	6.9	38.4	**41.9**	12.7	45.3	**54.6**

Stage	N	Strongly agree %	Agree %	Disagree %	Strongly disagree %	Combined positive %	Combined negative %
Question 7b My teachers are concerned about the future of the environment							
3	93	14.0	**67.7**	15.1	3.2	**81.7**	18.3
4	315	9.5	**55.2**	30.2	5.1	**64.7**	35.3
5	518	8.1	**55.6**	29.7	6.6	**63.7**	36.3
Question 7c It matters to my teachers that I understand environmental issues							
3	93	31.2	**51.6**	16.1	1.1	**82.8**	17.2
4	315	12.4	**55.9**	24.8	7.0	**68.3**	31.8
5	518	9.1	**56.2**	26.4	8.3	**65.3**	34.7
Question 7d In my family we talk about sustainability issues and the environment a lot							
3	93	12.9	**41.9**	34.4	10.8	**54.8**	45.2
4	315	5.7	21.6	**49.8**	22.9	27.3	**72.7**
5	518	6.2	17.6	**47.1**	29.2	23.8	**76.3**
Question 7e My parents are concerned about the future of the environment							
3	93	24.7	**51.6**	19.4	4.3	**76.3**	23.7
4	315	9.5	**40.0**	36.5	14.0	49.5	**50.5**
5	518	9.1	**42.5**	33.6	14.9	**51.6**	48.5
Question 7f It matters to my parents that I understand environmental issues							
3	93	33.3	**47.3**	15.1	4.3	**80.6**	19.4
4	315	11.1	**47.9**	29.8	11.1	**59.0**	40.9
5	518	10.2	**38.2**	35.3	16.2	48.4	**51.5**

* Note: The bolded values reflect the most frequent response patterns.

**Note: In this item the scoring was reversed, so that for this question 'strongly disagree' was assigned a numeric value of 4.

6.3.5 Frequency Distribution of Responses for the Awareness Scale

The first two items on this rating scale were designed to measure students' self-assessed levels of environmental sensitivity and knowledge. The frequency distribution of responses for each stage and for each item is reported in percentage form in Table 6.8.

Table 6.8

Frequency Distribution of Responses, as Percentages and by Stage for Awareness Scale Questions 2a & 2b

Stage	N	% response high	% response medium	% response low
Question 2a My level of interest - I would rate how much I notice these issues as				
3	39*	30.8	**61.5**	7.7
4	315	17.5	**68.3**	15.2
5	518	18.7	**67.8**	13.5
Question 2b My level of knowledge - I would rate how much I know about these issues as				
3	39*	23.1	**71.8**	5.1
4	315	11.4	**73.3**	15.2
5	518	12.0	**73.4**	14.7

* Note: The bolded percentages reflect the most frequent response patterns.

Question 2a was a single item rating students' own level of environmental sensitivity. In all stages the majority of students rated their level of environmental awareness as 'medium'. Only 7.7% of Stage 3 students rated their level of awareness as low, but nearly twice that percentage of Stage 4 and 5 students chose that response (15.2% and 13.5%, respectively).

Question 2b was a single item rating students' own level of environmental knowledge. For all stages a similar proportion of students rated their level of knowledge as 'medium' (71.8% for Stage 3, 73.3% for Stage 4 and 73.4% for Stage 5). Stage 3 students were twice as likely to rate their level of knowledge as high compared to Stages 4 and 5 (23.1%, 11.4% and 12.0%, respectively).

Question 3d was a single item which used a Likert-type scale to rate students' perception of how much is taught at school about environmental issues. The results for this question are outlined in Table 6.9. The majority of students in all stages agreed that a lot of environmental education occurs at their school, with 73.1% of Stage 3 students

choosing ‘strongly agree’ or ‘agree’. Similarly, 62.8% of Stage 4 students and 67.0% of Stage 5 students chose these responses.

Table 6.9

Frequency Distribution of Responses, as Percentages and by Stage for Awareness Scale Question 3d

Stage	N	Strongly agree %	Agree %	Disagree %	Strongly disagree %	Combined positive %	Combined negative %
Question 3d We learn quite a lot about environmental issues at school.							
3	93	14.0	**59.1**	25.8	1.1	**73.1**	26.9
4	315	11.7	**51.1**	28.3	8.9	**62.8**	37.2
5	518	14.3	**52.7**	28.2	4.8	**67.0**	33.0

Questions 4a – d asked students to rank the importance of four sources of information relating to environmental issues in terms of their importance, but not in relation to each other. The results are shown in Table 6.10.

Stage 3 students reported that they sourced ‘some’ of their information on environmental issues from their school and teachers, media and family, and ‘a little’ from their friends. Stage 4 students felt that they sourced ‘some’ of their information on environmental issues from their school and teachers, media and family, but got ‘very little’ from their friends. Stage 5 felt that they sourced ‘some’ of their information on environmental issues from their school and teachers, and from the media, but ‘little’ from their family and ‘very little’ from their friends.

Table 6.10

Frequency Distribution of Responses, as Percentages and by Stage for Awareness Scale - Question 4

Stage	N	Lots %	Some %	A little bit %	Very little %
Question 4a School and teachers					
3	93	47.3	**41.9**	10.8	0.0
4	315	35.9	**47.3**	11.4	5.4
5	518	39.2	**46.3**	11.0	3.5
Question 4b Media					
3	93	31.2	**37.6**	23.7	7.5
4	315	32.1	**32.7**	23.8	11.4
5	518	33.0	**42.1**	18.0	6.9
Question 4c Family					
3	93	36.6	**45.2**	15.1	3.2
4	315	16.8	**31.4**	30.2	21.6
5	518	10.8	25.9	**39.8**	23.6
Question 4d Friends					
3	93	2.2	26.9	**37.6**	33.3
4	315	3.2	12.4	26.0	**58.4**
5	518	3.3	11.0	23.0	**62.7**

It is interesting to note that in question 7d on the Attitude Scale Stage 5 students tended to feel that environmental and sustainability issues were not much discussed within their families. It is not surprising then that the family is not seen as a source of information on these issues. In fact, the majority of Stage 5 (63.4%) students feel they get 'little', or 'very little' of their information from their family. Friends are even less of a source; 85.7% stating they get 'little', or 'very little', of their information from their peers.

The next questions asked students to rank how they felt about some statements about environmental issues, science and technology. The results are presented in Table 6.11.

In only one item of this scale there was a notable difference in the results between the stages, with Stage 3 students more likely (53.7%) to agree that governments should take

the lead role in making changes which benefit the environment. Students from Stages 4 and 5 were more likely to disagree with this statement (51.4% and 53.1%, respectively), although for this item the responses were more evenly split between agreement and disagreement than for any of the other items in this question.

On the whole, a large majority of students agreed that the actions of individuals had an impact on the environment (agree: Stage 3 93.6%, Stage 4 81.3%, Stage 5 81.6%); that companies and business should make changes (agree: Stage 3 89.2%, Stage 4 91.4%, Stage 5 90.1%); and that although science and technology provide opportunities for their generation (agree: Stage 3 93.5%, Stage 4 85.0%, Stage 5 83.6%); they are not complacent that environmental problems will all be sorted out by others without them having to worry about them (disagree: Stage 3 54.8%, Stage 4 67.7%, Stage 5 72.8%).

Table 6.11

Frequency Distribution of Responses, as Percentages and by Stage for Awareness Scale Question 5a, b, c, f & g

Stage	N	Strongly agree %	Agree %	Disagree %	Strongly disagree %	Combined positive %	Combined negative %
Question 5a I think individual actions have an impact on the environment.							
3	93	28.0	**65.6**	6.5	0.0	**93.6**	6.5
4	315	19.7	**61.6**	15.6	3.2	**81.3**	18.8
5	518	24.1	**57.5**	14.3	4.1	**81.6**	18.4
Question 5b I think it is mainly up to governments to make changes to help the environment.							
3	93	24.7	29.0	**38.7**	7.5	**53.7**	46.2
4	315	18.4	30.2	**43.8**	7.6	48.6	**51.4**
5	518	11.0	35.9	**46.5**	6.6	46.9	**53.1**
Question 5c I think companies and businesses should make changes to help the environment.							
3	93	**50.5**	38.7	9.7	1.1	**89.2**	10.8
4	315	38.7	**52.7**	5.4	3.2	**91.4**	8.6
5	518	29.7	**60.4**	7.5	2.3	**90.1**	9.8

Stage	N	Strongly agree %	Agree %	Disagree %	Strongly disagree %	Combined positive %	Combined negative %
Question 5f I think they will sort it all out in time and I don't have to worry about environmental problems.							
3	93	7.5	37.6	**38.7**	16.1	45.1	**54.8**
4	315	5.7	26.7	**48.3**	19.4	32.4	**67.7**
5	518	4.8	22.4	**48.3**	24.5	27.2	**72.8**
Question 5g Because of science and technology, there will be more opportunities for my generation.							
3	93	38.7	**54.8**	5.4	1.1	**93.5**	6.5
4	315	22.5	**62.5**	11.4	3.5	**85.0**	14.9
5	518	22.6	**61.0**	13.5	2.9	**83.6**	16.4

Further analysis of question 5f shows that younger students were more optimistic, with Stage 3 responses split between 37.6% who thought environmental issues might be sorted out before they are adults, and 38.7% who disagree that that will occur. Stage 4 and 5 students were much surer that they *do* have to worry about environmental problems.

As with the items in the Knowledge Scale, there were correct responses to the seven items assessing Issue Identification Skills. Table 6.12 presents the level of item difficulty for these seven items, for each stage, in the form of percentages. As previously mentioned, item difficulty values can range from a low of 0% (i.e., no student responds correctly) to 100% (i.e., all students respond correctly). The items are ranked by degree of difficulty for each stage, where 1 represents the easiest (i.e. most correctly answered) question.

The items in this scale asked students to rate how dangerous they felt some environmental issues were. The majority of students were not able to identify the correct level of risk associated with these problems.

Table 6.12

Level of Item Difficulty of Items, Awareness Scale Question 25

Item #	Stage	n	Item difficulty (% correct)	Difficulty by Rank Stage 3	Difficulty by Rank Stage 4	Difficulty by Rank Stage 5
25a	3	91	38.5	4	4	5
	4	288	37.2			
	5	457	34.4			
25b	3	91	31.9	5	5	4
	4	288	35.8			
	5	457	35.0			
25c	3	91	30.8	6	6	6
	4	288	31.9			
	5	457	32.8			
25d	3	91	57.1	1	1	2
	4	288	56.6			
	5	457	50.3			
25e	3	91	42.9	3	3	3
	4	288	38.9			
	5	457	39.8			
25f	3	91	57.1	1	2	1
	4	288	49.7			
	5	457	53.6			
25g	3	91	14.3	7	7	7
	4	288	20.8			
	5	457	24.9			

Stage 3

In question 25a (pollution of Australia's lakes, rivers, and streams) the greatest percent of students (45.1%) felt the issue was 'very dangerous' instead of 'somewhat dangerous'. For question 25b (air pollution caused by industry), the greatest percentage of students in Stage 3 (53.8%) felt the issue was 'very dangerous' instead of 'somewhat dangerous'. Results for question 25c (pesticides and chemicals used in farming) showed that the majority of students chose 'somewhat dangerous', instead of 'very dangerous', with the results almost evenly split between 'very dangerous', 'somewhat dangerous' and 'I don't know' (30.8%, 34.1% and 26.4%, respectively). For question 25d (nuclear

power stations), a clear majority (57.1%) of students in Stage 3 correctly felt the issue was 'very dangerous'. Similarly, for question 25e (rise in global temperature caused by climate change), a majority (42.9%) of students in Stage 3 correctly felt the issue was 'very dangerous', although a significant number (22.0 %) responded 'I don't know'. In question 25f (air pollution caused by cars) the majority (57.1%) correctly identified the issue as 'somewhat dangerous'. Finally, in question 25g (modifying the genes of certain crops and animals), the majority of students (45.1%) chose 'I don't know' as their response, with only a minority (14.3%) correctly identifying the issue as 'not dangerous'.

Stage 4

In question 25a (pollution of Australia's lakes, rivers, and streams) the greatest percentage (45.8%) of students felt the issue was 'very dangerous' instead of 'somewhat dangerous'. For question 25b (air pollution caused by industry), the greatest percentage (49.7%) of students in Stage 4 felt the issue was 'very dangerous' instead of 'somewhat dangerous'. Results for question 25c (pesticides and chemicals used in farming) showed that the majority of students (41.3%) chose 'somewhat dangerous', instead of 'very dangerous'. For question 24d (nuclear power stations), a clear majority (56.6%) of students correctly felt the issue was 'very dangerous'. For question 25e (rise in global temperature caused by climate change), a slight majority of students correctly felt the issue was 'very dangerous', although almost the same number responded 'somewhat dangerous' (38.9% and 38.2%, respectively). In question 25f (air pollution caused by cars) the majority (49.7%) correctly identified the issue as 'somewhat dangerous'. Finally, in question 25g (modifying the genes of certain crops and animals), the majority of students (30.2%) chose 'I don't know' as their response, with the minority (21.2%) correctly identifying the issue as 'not dangerous'. For all items in this scale, a substantial number of students chose 'I don't know' as their response, from 10.1% in questions 25b to 30.2 % in question 25g.

Stage 5

In question 25a (pollution of Australia's lakes, rivers, and streams) the greatest percentage (49.0%) of students felt the issue was 'very dangerous' instead of 'somewhat dangerous'. For question 25b (air pollution caused by industry), the greatest percentage (48.6%) of students in Stage 5 felt the issue was 'very dangerous' instead of 'somewhat dangerous'. Results for question 25c (pesticides and chemicals used in farming) showed that the majority (44.0%) of students chose 'somewhat dangerous'. For question 24d (nuclear power stations), a majority (50.3%) of students correctly felt the issue was 'very dangerous'. Similarly, for question 25e (rise in global temperature caused by climate change), a majority (39.8%) of students in Stage 5 correctly felt the issue was 'very dangerous', although a significant number (36.8%) responded with 'somewhat dangerous'. In question 25f (air pollution caused by cars) the majority (53.6%) correctly identified the issue as 'somewhat dangerous'. Finally, in question 25g (modifying the genes of certain crops and animals), the majority of students (34.6%) chose 'somewhat dangerous' as their response, with only a quarter correctly identifying the issue as 'not dangerous', although as many students chose 'I don't know'.

6.3.6 Summary for the Awareness Scale

These results suggest that students have difficulty making sense of these environmental issues. Industrial air pollution and genetic engineering were rated as being more dangerous that they actually are. Only the risk associated with nuclear power stations, climate change and air pollution from cars was correctly assessed.

The level of difficulty for these items ranged from the low 10s (question 25g: Stage 3 = 14.3%) to the upper 50s (question 25d and f: Stage 3 = 57.1%). On all seven items, the difference between item difficulty levels for the Stage 3 and 5 samples never differed by more than eleven percent. Overall, students in all stages found these items to be moderately difficult, although Stage 3 students outperformed their older colleagues in questions 24a, d, e and f, Stage 4 were correct most often in question 25b, and Stage 5 students were correct more often only in questions 24c and g.

6.3.7 Frequency Distribution of Responses for the Action Scale

Self-Assessment of Commitment vs. Action

The items in this scale asked students to reflect upon their commitment to environmental action, compared to their actual level of action. Students did not rate their actual level of behaviour (question 2d: My level of actual action - I would rate how much I actually do) as positively as they did their intended behaviour (question 2c: My level of commitment to action - I would rate how much I want to help). These results are shown in Table 6.13.

Stage 3 students felt their commitment to action was high (48.7%) or medium (48.7%) for most students. Stage 4 students were less enthusiastic, with only 26.0% of students choosing a high level of commitment, and most (55.9%) choosing a medium level. Stage 5 students were even less likely to rate their level of commitment as high (18.3%), with most choosing medium (61.8%).

When this is compared to the students' assessment of their actual level of commitment, most (perhaps realistically), assessed their levels much lower, especially in Stages 4 and 5, where most students rated their level as medium (54.9% and 54.6%, respectively) or low (35.6% and 39.4% for Stages 4 and 5, respectively).

Table 6.13

Frequency Distribution of Responses, as Percentages, and by Stage for Action Scale Question 2c & d

Item #	Stage	N	Frequency Dist. of Responses %		
			high	medium	low
2c	3	39	48.7	48.7	2.6
	4	315	26.0	55.9	18.1
	5	518	18.3	61.8	19.9
2d	3	39	15.4	71.8	12.8
	4	315	9.5	54.9	35.6
	5	518	6.0	54.6	39.4

Familial Levels of Environmental Action

Question 8 was a single item rating familial levels of environmental action. Twenty possible environmental behaviours were listed, and students ticked those they knew their families practiced. A small number of students did not answer this question, as reflected in the number of responses listed in Table 6.14.

For Stage 3, the most common number of behaviours was eight or ten. For Stage 4 it was nine, and for Stage 5 it was ten. The results, as would be expected, are fairly consistent across the stages, with the difference between stages never more than 8%. Very few respondents added any comments in the 'Other' box, but activities suggested that could be added to the list included driving a hybrid vehicle or using grey water. Figure 6.1 illustrates the frequency with which the numbers of activities were practiced.

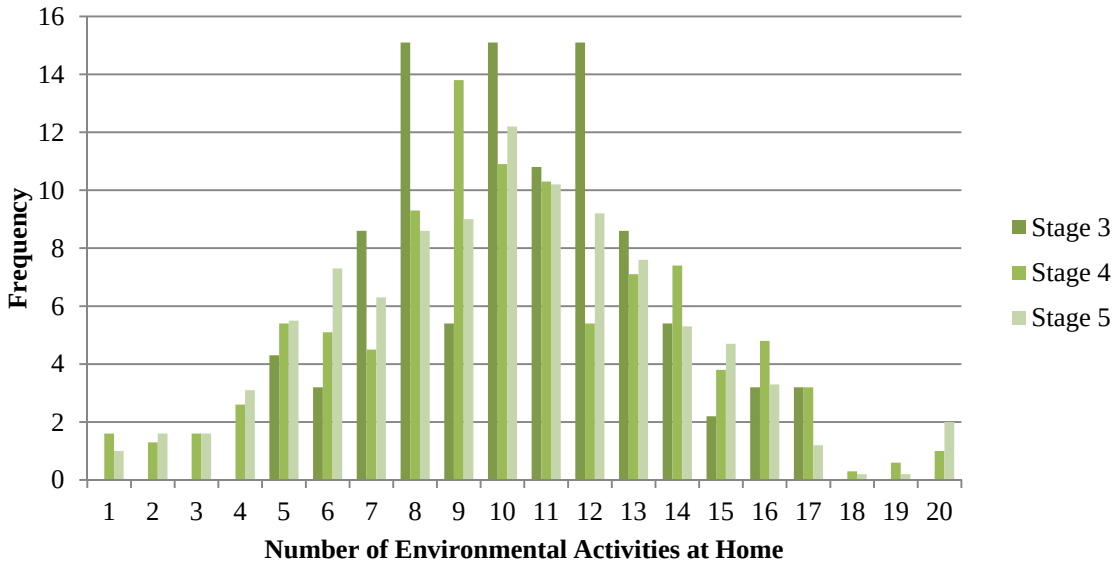


Figure 6.1 *Frequency distribution of number of home environmental activities, by stage*

Table 6.14

Frequency Distribution of Responses, as Percentages and by Stage for Action Scale Question 8

No. of actions	Frequency Dist. of Responses as Percentages		
	Stage 3	Stage 4	Stage 5
	N=91	N=288	N=457
1	0.0	0.0	0.4
2	0.0	1.0	1.1
3	0.0	1.7	1.5
4	0.0	2.4	2.8
5	3.3	4.9	5.5
6	3.3	5.2	7.4
7	8.8	4.9	5.7
8	15.4	10.1	8.8
9	5.5	13.9	9.8
10	15.4	11.8	12.7
11	11.0	10.4	10.7
12	14.3	5.9	9.0
13	8.8	7.3	8.3
14	5.5	7.3	5.7
15	2.2	4.2	5.3
16	3.3	4.9	3.5
17	3.3	3.5	1.3
18	0.0	0.0	0.2
19	0.0	0.7	0.2
20	0.0	0.0	0.0

In terms of which activities are most commonly practiced by families, the data is quite consistent across all three stages, and is presented in Figure 6.2 and Table 6.15. For the purposes of data analysis, the items were not listed in the order they appeared in the survey, rather they are re-grouped into six sub-categories: energy consumption, water consumption, transportation, food consumption, recycling, and participation in environmental activities.

Stage 3 students said their families were less likely to wash clothes in cold water; more likely to participate in an outdoor activity at least once a year, and more likely to have a vegetable garden at home. They were less likely to have a dual flush toilet (Stage 3: 48.4%, Stage 4: 75.7%, Stage 5: 76.6%), but many students were confused by this term, and this may explain the lower percentage. Primary school students were also twice as likely to ride a bicycle; perhaps a reflection of their age (Stage 3: 64.8%, Stage 4: 35.4%, Stage 5: 29.5%). They were also more likely to say that their family turned off electrical appliances when not in use (Stage 3: 85.7%, Stage 4: 75.7%, Stage 5: 66.3%). It could be speculated that this trend is simply because the parents of pre-teens are yet to give up nagging them to do so!

In 16 out of 20 behaviours the difference between the stages was no greater than 15%. It is possible that age alone explains why Stage 3 students know less about how the clothes in their house are washed, or what type of toilet they have, but are more likely to go camping with their family and ride a bike.

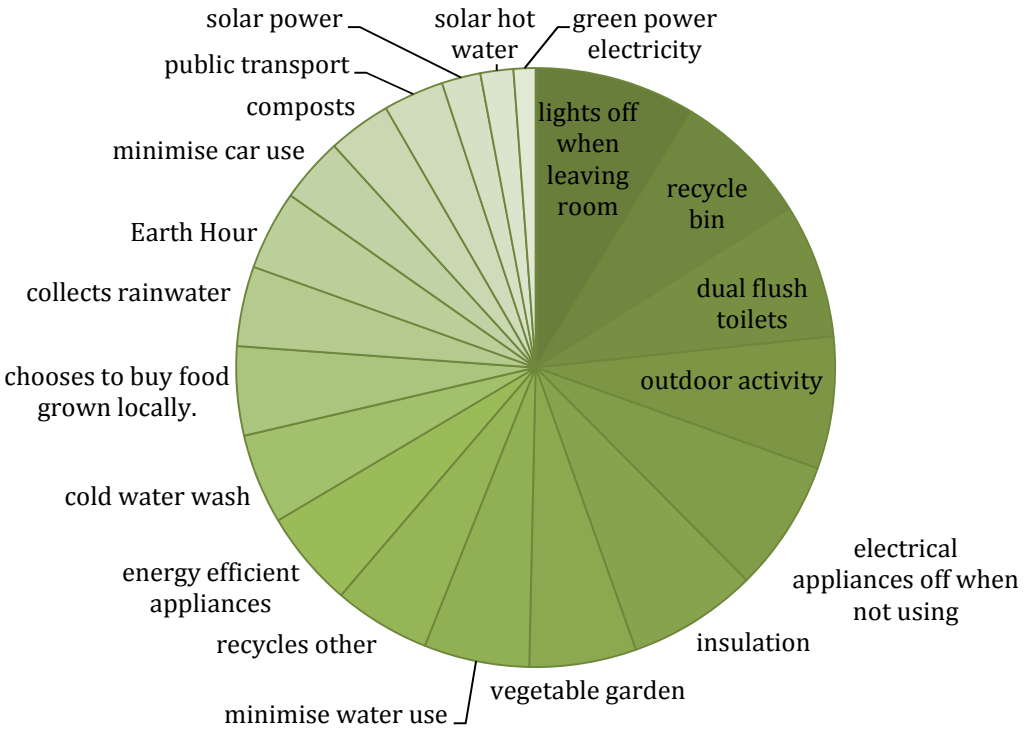


Figure 6.2 Frequencies of environmental activities practiced by households

Table 6.15

Frequency Distribution of Environmental Behaviours in the Home, Question 8

	% who practice this behaviour			
Stage	**3**	**4**	**5**	**Combined**
N	91	288	457	836
uses cold water to wash clothes	29.7	47.2	54.3	49.2
generates solar power	23.1	21.5	20.6	21.2
energy efficient appliances	48.4	49.3	55.6	52.6
has solar hot water	12.1	20.1	17.7	17.9
insulation in the roof, walls or under the floor	62.6	70.8	72.2	70.7
turns lights off when leaving a room	96.7	91.0	84.5	88.0
electrical appliances off when not using	85.7	75.7	66.3	71.7
buys green power electricity	11.0	12.8	11.6	12.0
public transport to get to work or school	30.8	35.4	31.9	33.0
rides bicycles or walks instead of car	64.8	35.4	29.5	35.4
has two button (dual flush) toilets	48.4	75.7	76.6	73.2
tries to minimise our water use	62.6	55.6	57.5	57.4
collects rainwater for drinking/garden	44.0	42.4	44.2	43.5
buys food grown locally	60.4	46.2	47.5	48.4
vegetable garden	69.2	57.6	56.5	58.3
worm farm, compost bin or Bokashi bucket	40.7	36.8	31.7	34.4
recycles by using the Council's bin	70.3	74.0	75.3	74.3
recycles other	59.3	54.5	50.3	52.8
outdoor activity at least once a year	86.8	75.7	66.7	72.0
took part in Earth Hour	41.8	45.8	42.0	43.3
other	1.1	1.0	2.0	1.6

Schools' Levels of Environmental Action

One of the items in the Action scale asked students to identify information about their school's environmental programs. When one walks into any school the similarities are more apparent than the differences, but there were in fact large differences in the sustainability practices practiced by the schools in the survey. It was postulated that students who were more aware of environmental or sustainability issues in general would be more aware of the activities carried out in their school. Similarly, schools with a strong interest in sustainability that are keen to involve their students will ensure that students are aware of what goes on in that school. There is no point a school running a paper recycling program, for example, if very few students are aware of it. Such a scenario would imply that the program has the support of few teachers, or only occurs in the administrative areas of the school and doesn't really involve the whole school. A school with a genuine commitment to ESD should have students who are aware of that commitment. It is possible, it should be noted, that some excellent initiatives can become so much a 'part of the furniture' that students do not notice them. At one high school, students walked past huge water tanks on their way into the school, but many students did not appear to have noticed their existence! Figure 6.3 outlines the frequency with which the sustainability activities were carried out in the schools in the survey.

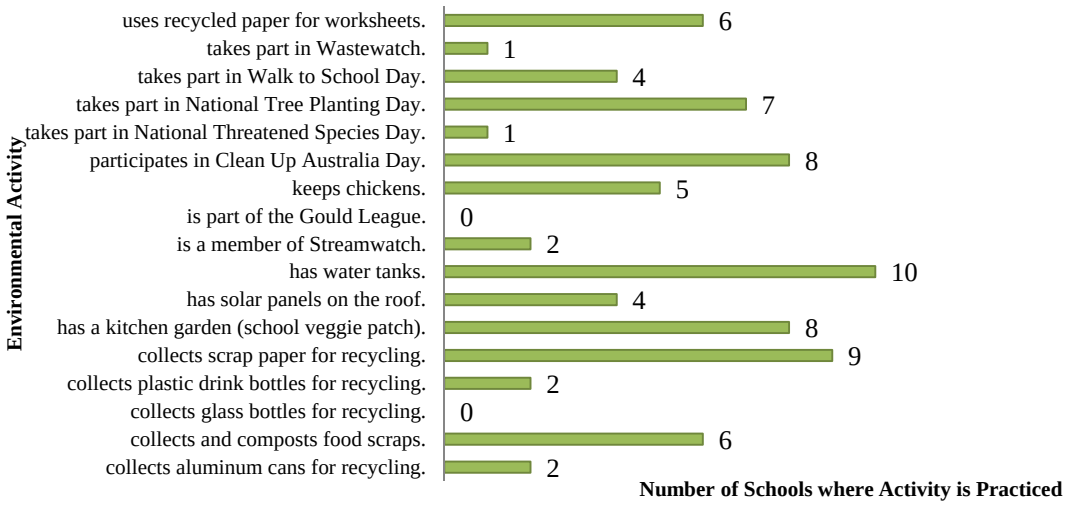


Figure 6.3 Frequency distribution of environmental activities in schools

The range of environmental activities carried out in the different schools varied between five and 11, with an average of 7.5. There were 20 possible activities listed in the survey, and although some of them were broadly similar (for example, recycling of glass bottles, plastic bottles and aluminium cans were listed as separate categories although they could potentially be co-mingled in a recycling bin), no school carried out more than half the possible activities. In order to allow meaningful comparisons to be made between schools, the number of activities correctly identified by students was converted to a score out of 20.

Within the range of activities actually carried out by schools, students were able to identify, on average, about half of the activities carried out in their school. Table 6.16 shows which environmental activities were carried out by each school, Table 6.17 sets out the unweighted data, by school, for Question 9, while Table 6.18 shows the weighted data. At the best performing school, the students identified, on average 77 percent of the environmental activities; while at the worst performing school students could only identify 38 percent.

Table 6.19 shows the data grouped by stage and demonstrates that Stage 3 students were more aware of the environmental activities carried out in their school, correctly identifying 68 percent of activities. Stage 4 and 5 students only identified 46 and 43 percent of activities, respectively.

6.3.8 Summary for the Action Scale

It is useful to briefly compare these findings to other known sources of data (where available). In 2013 there were 227,663 rooftop solar power systems in NSW, and 2.8 million households, meaning approximately 8 percent of households generated solar electricity. This study found that 21 percent of households generated solar power.

The 2011 Australian Bureau of Statistics (ABS) *Energy Use and Conservation Survey* reported that the majority of Australian households had some form of insulation (69%), concurring with this survey which found that 71 percent of households had insulation.

The ABS also found that solar energy was primarily used by households for heating water but that less than one in ten hot water systems were solar powered (8%), whereas this survey found that 18 percent of households used solar hot water systems.

Additionally, the ABS survey found that energy star and water efficiency ratings were considered by around half of all households when purchasing or replacing electrical appliances such as refrigerators, washing machines, dishwashers and clothes dryers. 53 percent of students in this survey felt that their family had energy efficient appliances.

The ABS (2013) found that 34 percent of Australian households, living in a dwelling where it was suitable to do so, had a rainwater tank. This was more common outside of capital cities where the number was 44 percent and just over 2.3 million households (26%) used their tank as a source of drinking water. This survey (conducted in outer metropolitan and regional areas) found that 44 percent of households collected rainwater for drinking or to use on the garden.

The majority of Australian households (79%) surveyed in 2013 had taken at least one step to save water inside or outside their home in the previous year. Of the 3.4 million households that saved water, using the half flush on a dual flush toilet was a common step taken (66%). This survey found that 57 percent of students felt their families tried to minimise water use, while 73 percent of students knew their household had a dual flush toilet, but the survey did not ask if that meant the option was used. The ABS reported that in 2007, 81 percent of Australian households had at least one dual flush toilet.

As at March 2009, there were 945,491 household customers in Australia paying for GreenPower, which equates to 12% of households (ABS, 2010). This survey found that 12% of households purchased GreenPower.

In 2006-07 NSW households generated 15,360,000 tonnes of waste, of which 7,995,000 or 52% was recycled. In this survey, 74% of students reported that their family used the recycling bin. Of course, it was not possible to discern how effectively they recycled.

Table 6.16

Descriptive Results for the Environmental Activities of Schools

School ID	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**
Stage	3	3	3	3	3	4/5	4/5	4/5	4/5	4/5
# of actions	10	7	6	5	9	7	5	11	9	6
collects aluminium cans for recycling								✓	✓	
collects and composts food scraps	✓				✓	✓		✓	✓	✓
collects glass bottles for recycling										
collects plastic drink bottles for recycling								✓	✓	
collects scrap paper for recycling	✓	✓	✓	✓	✓		✓	✓	✓	✓
has a kitchen garden	✓	✓	✓		✓	✓		✓	✓	✓
has solar panels on the roof				✓	✓	✓	✓			
has water tanks	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
is a member of Streamwatch/Waterwatch	✓							✓		
is part of the Gould League										
keeps chickens/livestock					✓	✓		✓	✓	
participates in Clean Up Australia Day	✓	✓	✓	✓			✓	✓	✓	✓
takes part in National Threatened Species Day					✓					
takes part in National Tree Planting Day	✓	✓		✓	✓	✓		✓	✓	
takes part in Walk To School Day	✓	✓	✓			✓				
takes part in Wastewatch	✓									
uses recycled paper for worksheets	✓	✓	✓		✓		✓	✓		

Table 6.17

Descriptive Statistics for Unweighted Data by School, Action Scale Question 9

School ID	A	B	C	D	E	F	G	H	I	J
# of actions	10	7	6	5	9	7	5	11	9	6
N*	19	33	29	8	2	31	66	297	203	148
Mean**	6.7	4.7	4.6	2.6	3.5	3.4	2.6	4.8	3.4	3.0
SD	1.5	1.7	1.4	0.7	0.7	1.7	1.1	2.2	1.9	1.4
Median	7	5	5	3	3	3	3	5	3	3
Mode	8	5	5	3	n/a	3	2	5	2	2
range	6	5	5	2	1	6	4	10	8	5

*Note: Students who did not answer this question were removed from the sample.

**Note: Maximum score 10

There are several reasons these statistics cannot necessarily be directly compared, for example some of the data is several years old and many of these behaviours are changing rapidly. In 2007 24 percent of Australian households had a water tank installed, but by 2010 the number was 32 percent (ABS, 2013), one example of how rapidly some sustainability practices become mainstream. Another is that many of the students surveyed lived in regional cities, in less affluent areas and on farms. Students from inner city or suburban schools may have reported different responses, especially to questions about public transport use, solar electricity and rainwater for drinking. Nonetheless, the correlation between the figures from this survey, and from the ABS suggests that the findings are sound.

Table 6.18

Descriptive Statistics for Weighted Data by School, Action Scale Question 9

School ID	A	B	C	D	E	F	G	H	I	J
N*	19	33	29	8	2	31	66	297	203	148
Mean**	13.4	13.4	15.3	10.5	7.8	9.7	10.2	8.8	7.5	10.1
Av. % correct	67	67	77	53	39	49	51	44	38	51
SD	3.1	4.8	4.6	3.0	1.6	4.9	4.3	3.9	4.3	4.5
Median	14.0	14.3	16.7	12.0	7.8	8.6	10.8	9.1	6.7	10.0
Mode	16.0	14.3	16.7	12.0	n/a	8.6	8.0	9.1	4.4	6.7
range	12	14	17	8	2	17	16	18	18	17

*Note: Students who did not answer this question were removed from the sample.

** Note: Maximum score 20

Table 6.19

Descriptive Statistics for Weighted Data by Stage, Action Scale Question 9

Stage	3	4	5	Total
N*	91	288	457	836
Mean**	13.6	9.2	8.6	9.4
Av.% correct	68	46	43	47
SD	4.4	4.3	4.3	4.6
Median	14.3	9.1	8.6	9.1
Mode	20.0	9.1	6.7	6.7
range	17	18	18	18

*Note: Students who did not answer this question were removed from the sample.

** Note: maximum score 20

In 2013, the Australian Centre for Cultural Environmental Research conducted a study in the Wollongong area to assess environmental attitudes and behaviours. They found that the range of households in Australia, from single person, to large extended families, meant that households did not "consume stuff or approach environmental issues in identical or predictable ways" (p. 34). They found that common contradictions existed, for example wealthier households were twice as likely to install solar power, but more likely to use air-conditioning and that "high levels of consumption in affluent households make practical sustainability difficult" (p. 6). They found that poorer households expressed less interest in sustainability, but their relative poverty meant they were less likely to own plasma televisions or clothes dryer. They also practiced money saving behaviours, such as not leaving lights on, taking shorter showers, buying toilet paper made from recycled paper and 'environmentally friendly' detergents. While the younger generations expressed more concern about climate change, older couples undertook more sustainable practices. Indeed, the study concluded that many sustainable practices are carried out for reasons of thrift, or because people dislike waste.

This study surveyed high school students, and so investigated the household practices of families with children, but did not collect any information about the type of household the survey participants lived in. None of the schools surveyed were in areas where the Index of Community Socio-educational Advantage was much above or below the average value of 1000.

In summary, it appears that schools are not implementing all the sustainable practices they potentially could, and students are not particularly aware of the sustainable practices that are undertaken.

6.3.9 Summary for all the Scales

Within the *AELQ*, the Knowledge Scale component means, after weighting, were 56.0 for Stage 3; 58.7 for Stage 4; 62.2 for Stage 5; and 60.4 for the Grand Mean combined of the three stages. The Attitude Scale component means were 76.4 for Stage 3; 66.7 for Stage 4; 65.3 for Stage 5; and 69.5 for the Grand Mean combined of the three stages.

The Awareness Scale component means were 70.4 for Stage 3; 67.1 for Stage 4; 67.5 for Stage 5; and 68.3 for the Grand Mean combined of the three stages. The Action component score was 61.0 for Stage 3, 50.7 for Stage 4, and 48.3 for Stage 5, and 50.5 for the Grand Mean combined. Finally, the *Australian Environmental Literacy Quotient* (AELQ) composite scores (the combined means of all environmental literacy components for the each stage and the stages combined) were 263.9, 245.3, 245.4 and 247.4, respectively.

Additional insight into environmental literacy can be gained from examining the weighted mean scores associated with the four components of environmental literacy included in the measuring instrument used in this research (each component with a possible value of 100). Of the four environmental literacy components, the highest scores (combined Stages 3, 4 and 5 grand mean) were attained in Attitude (69.5), with slightly lower scores in Awareness and Knowledge (68.3 and 60.4, respectively). The lowest scores were observed in the component of Action (50.5).

In the components that focussed on performance (i.e. where students were asked to demonstrate knowledge or skills), Stage 5 students out-scored Stage 4 and 3 students in the area of Knowledge. This might be expected due to developmental differences and number of educational experiences between the three groups. In the areas of Attitude, Awareness and Action however, Stage 3 students outperformed Stage 4 and 5 students, who scored almost identically. This suggests that Stage 3 students are better at understanding the relative gravity of environmental issues, and the seriousness with which these issues are regarded by their parents and teachers, feel more empowered to take action, and undertake more sustainable practices, be it at home or school. This resulted in some Stage 3 students actually having a higher AELQ than older students, although much of this difference is due to the large sample sizes in Stages 4 and 5.

6.4 Correlations between Scales

The item means of the Attitude and Awareness Scales were calculated, and the scales correlated to determine if they were measuring different aspects of environmental literacy. The correlation between Attitude (X = 2.60, *S* = 0.43) and Awareness (X = 2.43. *S* = 0.42) was 0.46. When this value is considered in relation to the reliabilities, it suggests that the two scales are measuring different aspects of environmental literacy.

Two of the research questions of this thesis concerned themselves with establishing whether there is a link between the level of environmental literacy of a student and the extent of any environmental/sustainability practices in the home or school. Research Question Four asked: *Do the sustainability practices of the school contribute to students' values and attitudes towards environmental issues?*; and Research Question Five asked: *Do the sustainability practices in the home have a greater influence on the values and attitudes towards environmental issues than the practices at the student's school?*.

The findings of this study indicate that there is not a strong link between the environmental practices of a school and either the positive attitude or the level of environmental literacy of students. These results are summarised in Table 6.20 which show the AELQ correlated with the number of activities in the school correctly identified by the student. The table also outlines the correlations between the number of activities in the home and the AELQ, and the number of activities in each case against each of the scales of the AELQ (Knowledge, Attitude, Awareness and Action).

Table 6.20

Correlations between Environmental Actions and the AELQ, by Stage

	Stage 3		Stage 4		Stage 5		Total
Correlated Variables	**n**	***r***	**n**	***r***	**n**	***r***	***ρ***
N (activities at school) & AELQ	91	0.57	288	0.54	457	0.46	0.52
N (activities at school) & Attitude component	91	0.34	288	0.24	457	0.05	0.22
N (activities at school) & Knowledge component	91	0.16	288	0.15	457	0.15	0.11
N (activities at school) & Awareness component	91	0.27	288	0.19	457	0.13	0.18
N (activities at home) & AELQ	91	0.65	288	0.60	457	0.59	0.59
N (activities at home) & Attitude component	91	0.32	288	0.29	457	0.30	0.29
N (activities at home) & Knowledge component	91	0.46	288	0.21	457	0.24	0.24
N (activities at home) & Awareness component	91	0.33	288	0.31	457	0.29	0.30

For all three stages, the number of activities in the school correlated against the AELQ of the student gave values less than 0.57. The correlation was highest for Stage 3 students and lowest for Stage 5 students. For the combined sample, ρ = 0.52. In the second case, the number of activities in the home correlated against the AELQ of the student gave values less than 0.65. Stage 3 students had the highest correlation, with a value of 0.65, while Stages 4 and 5 were 0.60 and 0.59, respectively. The trend in both

cases was for Stage 3 students to have a higher correlation, for Stage 4 to be less, and Stage 5 less again.

The correlation between the number activities carried out at school and the Attitude component of the AELQ is stronger than with Knowledge or Awareness, with $\rho = 0.22$, despite the very low correlation coefficient for Stage 5 ($r = 0.05$). At home the picture is a little different, with Awareness having a slightly greater relationship ($\rho = 0.30$) than Attitude ($\rho = 0.29$) or Knowledge ($\rho = 0.24$). This is logical, as a greater number environmental activities carried out in the home should mean the student has a higher awareness of sustainable practices and a more positive attitude towards the environment.

The results support the hypothesis that the environmental behaviours modelled in the home have more influence on students that the activities carried out in their school.

A correlation matrix for the four individual component scales which make up the AELQ is outlined in Table 6.21. There was some correlation between Knowledge and Awareness ($\rho = 0.56$), and between Attitude and Awareness ($\rho = 0.53$), but none of the correlations was strong enough to be particularly noteworthy.

Table 6.21

Correlation Matrix of the Scales in the AELQ

	Knowledge	Awareness	Attitude	Action
Knowledge	1.0			
Awareness	0.56	1.0		
Attitude	0.25	0.53	1.0	
Action	0.23	0.34	0.40	1.0

The number of activities practiced in each school, as correctly identified by the students, was correlated against the AELQ of the students at that school. As the results in Table

6.22 show, there is no apparent relationship between the two sets of data, with the students at schools B and D generating the highest correlation, even though school D had one of the lowest number of environmental practices. The lowest correlation occurred at School A, which actually had one of the higher numbers of sustainable practices. This confirms that the environmental practices carried out within a school appear to have little impact on the level of environmental literacy of students. As mentioned before, a school may carry out some worthy and necessary sustainable practices, but that does not mean that students are made aware of it; such things can be as much a 'part of the furniture' as the buildings and daily routines that students are almost oblivious to them. This survey did not measure how actively schools use their environmental practices as opportunities for learning by incorporating them into their teaching programs.

Table 6.22

Correlations between Environmental Actions of Schools and the AELQ, by School

School ID*	A	B	C	D	F	G	H	I	J
N	19	33	29	8	31	66	299	205	157
# of actions**	55.6	38.9	33.3	27.8	38.9	27.8	61.1	50.0	33.3
r	0.11	0.72	0.52	0.63	0.58	0.60	0.56	0.39	0.46

*School E was not included in this analysis as the number of survey participants was too small to be statistically significant.

** Number of environmental actions carried out by the school as a percentage of the possible actions.

6.5 The NSW Science Syllabus and Environmental Literacy

In the NSW Science Syllabus (2003), as discussed in Chapter 2, there is not a lot of specific content about environmental science contemporary issues around sustainability and environmental problems. In Stages 4 and 5 students are expected to develop "positive attitudes" (p. 12) towards the environment, recognising the "role of science in providing information about issues" and acknowledging "their responsibility to conserve, protect and maintain the environment for the future" (p. 16). While valuing and appreciating science, they should also be able to critically evaluate the "consequences of the applications of science" (p. 24). In this measuring instrument, questions 2, 3, 5 and 7 concerned these ideas.

There is very little specific content related to environmental issues in the Stage 3 NSW Science and Technology Syllabus (2006), but students are expected to understand "the likely impact of removing one form of life from a food chain" and to have tested for water pollution in a local waterway (p. 25), to have produced recycled paper and have weighed up some of the pros and cons of mining on aboriginal land (p. 29). Additionally, they should have constructed a working model to "demonstrate the use of a renewable energy source" (p. 27) and devised an experiment to "simulate the effects of significant weather changes on flora and vegetation" (p. 31).

It can be assumed that all the students who completed this survey (if they attended primary school in NSW) should have had these experiences. Questions 6g, 19 and 25a related to these concepts.

By the end of Stage 4 of the Science Syllabus (2003) students should have covered the content tested in this survey, namely to "identify gases that comprise the greater percentage of air", and "to describe the importance of atmospheric gases, including … greenhouse gases, to life on Earth" (p. 37), to "describe … how producers, consumers and decomposers are related", to discuss "some effects of bushfires, drought and flood on Australian ecosystems" (p. 39), to identify and describe uses of fossil fuels and

identify “renewable and non-renewable sources of energy” (p. 39). These concepts were tested, either directly or indirectly, in questions 6a and d, 11, 12, 13, 14, 24b, c, d and f.

Finally, students completing year 10 should have studied “some impacts of human activities on ecosystems”; “the importance of energy as a resource”; the “excessive use of fossil fuels as a contributing factor to a greenhouse effect”; pollution as “contamination by unwanted substances”; and strategies to conserve, protect and maintain “the quality and sustainability of the environment” (p. 40). These concepts were tested, either directly or indirectly, in questions 6b, c, e and f, 10a-c, 15, 16, 17, 18, 20, 21, 22, 23, 24a, e, g, and h, and 25b-g.

The results for these Knowledge and Awareness Scale questions, listed by the stage when the concepts are introduced to students, are outlined in Table 6.23.

The survey results indicate that these concepts, as would be expected, are generally better understood as students’ progress through their schooling. In 21 of the 38 items Stage 5 students were more likely to answer the question correctly. The results for items 6a, b, c and d and 24b suggest that the students have already acquired a sound knowledge before the content is covered in the classroom, as not only do most students answer correctly, the results across the three stages are consistently high. The results across the stages are also very consistent for questions 10a, 17, 24h, 25a, b, c and e; although only about one-third to one-half of students were able to answer these items correctly. In three questions the level of student knowledge actually decreased steadily between Stages 3 and 5.

It is also apparent that there is no pattern of improvement aligned with progression through the years of schooling, as might be anticipated. However, if this pattern were to be measured a study would need to measure students of similar calibre in each stage, e.g. only the top classes in a school, or alternatively measure students longitudinally over their schooling to assess their progress.

Table 6.23

Percentage of Students Answering Knowledge and Awareness Questions Correctly, by Stage

Covered in Stage 3			
Question	% correct, Stage 3	% correct, Stage 4	% correct Stage 5
6g	29.7	38.4	**49.4***
19	49.5	**60.0**	58.5
25a	**38.5**	37.2	34.4
Covered in Stage 4			
Question	% correct, Stage 3	% correct, Stage 4	% correct Stage 5
6a	**90.1**	89.5	89.2
6d	70.3	72.4	**81.9**
11	30.8	44.1	**46.1**
12	24.2	31.4	**45.2**
13	9.9	11.7	**14.5**
14	47.3	55.9	**64.9**
24b	71.4	67.0	**72.4**
24c	46.2	50.8	**59.1**
24d	63.7	67.9	**72.4**
24f	48.4	51.7	**62.4**
Covered in Stage 5			
Question	% correct, Stage 3	% correct, Stage 4	% correct Stage 5
6b	79.1	76.2	**79.7**
6c	89.0	85.1	**90.3**
6e	78.0	77.5	**78.2**
6f	**56.0**	35.6	41.7
10a	45.1	42.9	**46.3**
10b	31.9	42.2	**44.2**
10c	18.7	29.8	**32.6**
15	16.5	22.6	**30.7**
16	2.2	8.9	**9.8**
17	37.4	43.8	**40.9**
18	**15.4**	13.0	11.6

Question	% correct, Stage 3	% correct, Stage 4	% correct Stage 5
20	5.5	9.8	**12.0**
21	7.7	10.2	**17.6**
22	36.3	48.6	**56.9**
23	19.8	16.5	**25.1**
24a	58.2	65.4	**68.1**
24e	30.8	31.4	**42.9**
24g	28.6	29.8	**35.7**
24h	54.9	49.5	**55.0**
25b	31.9	**35.8**	35.0
25c	30.8	31.9	**32.8**
25d	**57.1**	56.6	50.3
25e	42.9	38.9	**39.8**
25f	**57.1**	49.7	53.6
25g	14.3	20.8	**24.9**

* Note: The bolded values reflect the most frequent response patterns.

In summary, the results presented in Table 6.23 suggest that the content covered in the NSW Science Syllabus is not systematically building the environmental literacy of students. Concepts such as the extinction of one species having an impact on others; the warming of the planet; the dramatic changes in climate predicted to occur; and the anthropogenic nature of global warming appear to be well accepted, but acquired almost randomly, certainly well before they are studied formally in science. Other more difficult concepts such as the low risk associated with genetic engineering and effects of climate change such as rising sea levels, although more correctly answered by older students, do not appear to have been understood by as many students. Although it is heartening to see that most students understand the very broad concepts that underpin the sustainability paradigm, many of the more complex concepts are not well understood.

Although it is impossible to speculate too deeply about where students are picking up the concepts needed to build environmental literacy, it seems that a systematic study via

the content of the syllabus is not developing high levels of environmental literacy. The inference is that a new approach is needed. The continuous reference to sustainability across all areas of schooling, as suggested by the literature surrounding Education for Sustainable Development, and as described (all be it half-heartedly) in the new national Curriculum should be the preferred pedagogy, rather than relying on students acquiring science concepts as they move through their studies.

6.6 The AELQ and Environmental Literacy

In Section 4.2 the concept of a Scale of Environmental Literacy, as developed by Bybee (1997), O'Riordan (1981), Roth (1992) and Orr (1990, 1992) was discussed. The achievement standards in the Environmental Literacy Scale take the form of a hierarchy of four levels, and describe the kinds of knowledge, skills and understandings typically displayed by students at those levels. The levels, although useful, do not allow the environmental literacy of any given student to be determined, except in a subjective, almost intuitive, sense. The goal of the measuring instrument developed in this thesis is to allow a value, the *Australian Environmental Literacy Quotient* (AELQ), to be assigned to each of the bands in the Scale, thus allowing the level of environmental literacy of students to be definitely determined.

The process of matching levels of achievement from the AELQ to the bands within the Scale of Environmental Literacy was similar to that followed in outcomes based assessment, such as in the NSW Higher School Certificate, when the cut-off marks from the exam are tied to the descriptive bands of student achievement. To inform the decision, the statistical data was reviewed showing how the students typically performed in each question. The questions were considered one at a time and the mark it was believed a student on the borderline between two levels might respond was recorded. The marks were then added and a total mark corresponding to the borderline was obtained. Individual student responses at or around the proposed cut off points were then reviewed, and the cut–off points further refined.

Because some students may have a very high positive attitude towards attacking environmental problems, for example, but a very low level of knowledge about the issues, attempting to simply add together the four weighted scales and use the total as the AELQ is potentially difficult. A high score in the Attitude Scale may mask a lower score in the Knowledge Scale and give the impression the student has a higher level of environmental literacy than they might it a Knowledge Scale alone were used. Nonetheless, a sense of understanding the importance and gravity of environmental issues and an appreciation of the role of business, government and the individual in tackling them is crucial to a broad understanding of the issues, and so the Attitude and Action Scales are also important components of environmental literacy. In the same way a well-rounded individual, it might be argued, needs a healthy EQ as much as high IQ, environmental literacy is more than just having a good level of knowledge of the issues.

The survey sample (with students who did not complete questions 8 or 9) consisted of 836 students. The consistency of the range for each of the scales, shown in Table 6.24, demonstrates that none of the components of the survey overwhelms the sum of the four scales.

Table 6.24

Ranges of the Values for each Scale in the AELQ Survey

Scale	Range
Knowledge	18 - 91
Awareness	38 - 94
Attitude	28 - 91
Action	14 – 93
AELQ	123 - 339

Figure 6.4 shows the frequency distribution of the AELQ.

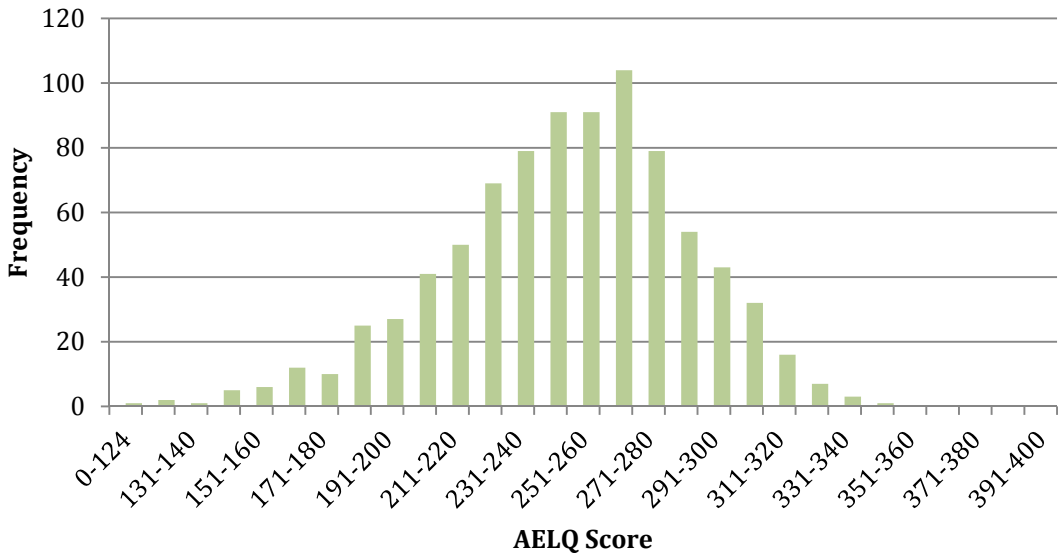


Figure 6.4 Frequency distribution of AELQ scores

The cut-off marks for each of the bands in the Scale of Environmental Literacy were determined as previously described and are outlined in Table 6.25.

Table 6.25

Levels of Environmental Literacy as determined by the AELQ

Level of Environmental Literacy	**Score achieved on AELQ**
Environmental Illiteracy	0 - 124
Nominal Environmental Literacy	125 - 199
Functional Environmental Literacy	200 - 274
Highly Evolved Environmental Literacy	275- 400

Only one student who undertook this survey would be considered to be environmentally illiterate. This student chose 'I don't know' as the answer to all of the questions on the Knowledge Scale, and that he learnt very little about environmental issues from the media his family or friends, or at school. He felt it did not matter to his family or teachers that he understood about environmental issues. Nonetheless, he professed to worry about the future of the environment, and identified some environmental practices at his school and in his home. It is likely that this is a non-serious attempt at the survey.

A small number of students skipped questions 8 and 9, which were the only questions where it was possible to move through the survey without choosing responses. Only the Attitude Scale was impacted, and the data from the other scales was able to be analysed. These students' responses were removed from the final analysis, however, because all four scales needed to be added together to produce an AELQ. In the same way, a small number of students ticked every single response in questions 8 and 9. Their non-serious responses were also removed from the final analysis.

It is unlikely that students in NSW schools, by Years 5 and 6 would be environmentally illiterate given the overwhelmingly positive attitude the students in the survey demonstrated towards the environment and the need to understand and take action. The majority of students also knew some of the basic principles underlying concerns about the environment, namely that the planet is becoming warmer and the climate is changing; that the extinction of one species has an impact on other species; and that human activity is the main reason for climate change. Thus it would be expected that the students with the lowest survey results would fall in the *nominal environmental literacy* band. Table 6.26 summarises the results within each band of the AELQ.

Table 6.26

Descriptive Results of Each Band within the AELQ

Level of Enviro Literacy	N	Stage	% of each Stage	AELQ Mean	SD	Knowledge Mean	Awareness Mean	Attitude Mean	Action Mean
Illiterate	1	3	0	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
		4	1						
		5	0						
Nominal	88	3	4	179	17.5	38	50	56	35
		4	11						
		5	12						
Functional	550	3	6	243	20.0	61	68	66	48
		4	66						
		5	67						
Highly Evolved	197	3	40	293	15.1	73	78	77	67
		4	23						
		5	21						

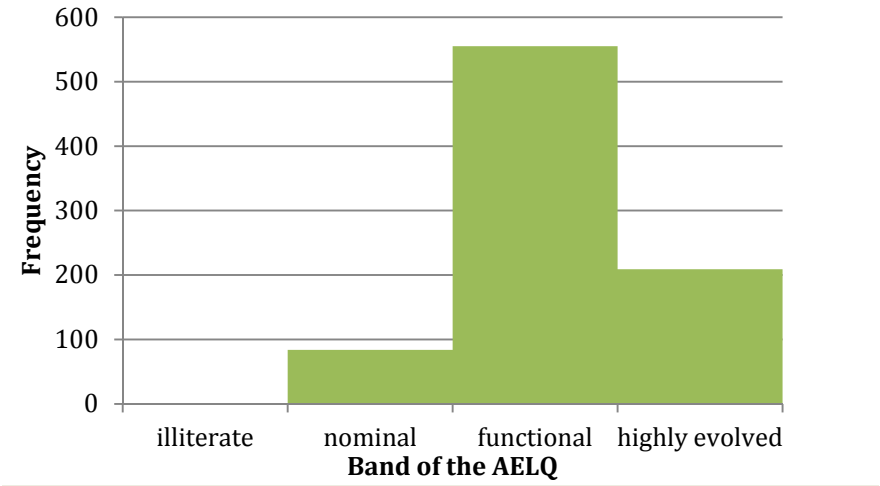


Figure 6.5 Histogram of the AELQ scores for all students

Each of the scales which make up the AELQ was correlated against the AELQ total within each band. Table 6.27 shows that there is no clear correlation between any one of the scales and the AELQ, which indicates that all four scales are needed to give the overall level of environmental literacy for a student.

Table 6.27

Correlation of Each Scale with the AELQ, for Each Band

Band	N	Correlation
Knowledge component vs. AELQ		
Nominal	93	0.41
Functional	568	0.49
Highly Evolved	175	0.37
Attitude component vs. AELQ		
Nominal	93	0.42
Functional	568	0.47
Highly Evolved	175	0.56
Awareness component vs. AELQ		
Nominal	93	0.56
Functional	568	0.57
Highly Evolved	175	0.41
Action component vs. AELQ		
Nominal	89	0.33
Functional	535	0.50
Highly Evolved	151	0.49

Students with Nominal Environmental Literacy

Some 10.5% of students who completed the survey were determined to be *nominally environmentally literate*, with an average AELQ of 179. A student at this level is beginning to identify environmental problems and the issues associated with them. Students in this band can recognise some basic terms used to describe environmental

issues, but either lack knowledge of specific concepts, have a naïve understanding or may possess misconceptions about the issues. Students with nominal environmental literacy have some awareness and sensitivity towards the impact of humans on natural systems, but tend to rate their levels of interest, knowledge, commitment and action as low or medium.

The descriptive results for the Knowledge Scale for students in this band are outlined in Table 6.28. Around half of these students either were not sure or disagreed that the planet is warming and the climate changing (40%), that human activity is the main cause (55%), burning of fossil fuels the main source of greenhouse gases (51%) and that the climate will change dramatically in their lifetime (49%). 80% of these students were not sure or disagreed that Australia is overpopulated in terms of the carrying capacity of the environment, and 49% were not sure or disagreed that there was insufficient water for our future needs. For all other questions on the Knowledge scale, 'I don't know' was the most common response.

The attitude of students with nominal environmental literacy was low. They disagreed that sustainability issues and the environment were often talked about at their school (75%), felt the issues didn't matter to their teachers (60%), or that teachers cared that students understood them (52%). They disagreed that sustainability issues and the environment were often talked about at their family (98%), and only about one third thought the issues mattered to their parents (36%), and that these parents cared that their children understood them (31%). The descriptive results for the Attitude Scale for students in this band are outlined in Table 6.29.

In terms of questions from the Awareness Scale, these students aren't typically interested in what they learn about the environment, but are about evenly split on whether they learn a lot about environmental issues at school, if what they learn worries them, and if they feel they can help with solutions to the problem. They feel their main source of information is school, followed by the media, but don't rate them highly; saying they receive 'some' or 'a little bit' of their information this way. They generally agree that individuals have a role to play in tackling environmental issues, but place the

role of businesses above that of government in tackling the problems. About half of these students don't feel a sense of responsibility toward these issues and about the same number don't feel they understand the sorts of behaviours they can do to help; indeed about half of them think the problems will be sorted out in time for them to *not* have to worry, putting their faith in rapid progress in science and technology. The majority of these students chose 'I don't know' when asked to assess the risk of a range of environmental issues. The descriptive results for the Awareness Scale for students in this band are outlined in Table 6.30.

The descriptive results for the Action Scale for students in this band are outlined in Table 6.31. The average number of activities reported as being carried out by the families of students in this band was seven, and the average number at school (correctly identified and weighted) was six.

Although much of the description given in the Environmental Literacy Scale matches with the typical student described above, this author cannot agree that the assertion in the Scale that students with nominal environmental literacy realise that unbridled consumption and economic growth cannot continue, that individuals have a role to play and that raising environmental awareness and concern is necessary within society and education. Whether through scepticism or ignorance, students at this level of environmental literacy do not demonstrate the positive attitude, developing level of awareness or the knowledge required to equip them to take their place as scientifically literate citizens who will be voting and making their own purchasing decisions in a few short years. This is especially of concern given that 63% of the students in this band were Stage 5 students, nearly at the end of their schooling.

Students with Functional Environmental Literacy

The majority of students (65.8%) who completed the survey can be described as having functional environmental literacy, with an average AELQ of 243. Students at this level are able to use environmental vocabulary with the correct definitions and in the appropriate context. They understand the organisation and functioning of environmental

systems and their interaction with human systems. Such a student possesses the knowledge and skills to recognise which problems are of concern and begins to understand the sort of actions that need to be taken. Students with functional environmental literacy have more awareness and sensitivity towards the impact of humans on natural systems, and tend to rate their levels of interest, knowledge and commitment as medium, and their level of action as medium to low.

Almost all of these students are either entirely or mostly sure that the planet is warming and the climate changing (93%), that human activity is the main cause (80%), burning of fossil fuels the main source of greenhouse gases (78%) and that the climate will change dramatically in their lifetime (79%). 59% of these students were not sure or disagreed that Australia is overpopulated in terms of the carrying capacity of the environment, and 57% were not sure or disagreed that there was insufficient water for our future needs. In only nine of the other questions on the Knowledge scale were 50% or more of students able to choose the correct response.

The attitude of students with functional environmental literacy was more positive than the students in the band below them. They agreed that sustainability issues and the environment were often talked about at their school (66%), although they felt the issues did matter to their teachers (65%), and that they cared that their students understood them (68%). They disagreed that sustainability issues and the environment were often talked about at their family (79%), and only about half thought the issues mattered to their parents (49%), and that they cared that their children understood them (51%).

In terms of questions from the Awareness Scale, these students agree they are interested in what they learn about the environment, that they learn a lot about environmental issues at school, and that what they learn worries them, but not that they feel they can learn what they can do to solve the problems. They feel their main source of information is school, followed by the media, and rate them highly; saying they receive ‘lots’ and ‘some’ of their information this way. They get ‘a little’ of their information from their families, but ‘very little’ from their friends.

They overwhelmingly agree (83%) that individuals have a role to play in tackling environmental issues, but place the role of businesses (92%) above that of government (45%) in tackling the problems. The majority (83%) of these students express a positive attitude towards their role in tackling these problems, and they feel they understand the sorts of behaviours they can do to help (81%). Though they have faith in the positive benefits of science and technology (87%), 88% of them do not think environmental problems will be sorted out in time for them to *not* have to worry; indeed 52% think science and technology make our way of life change too fast. When asked to assess the risk of a range of environmental issues, these students were reasonably able to correctly identify them.

The average number of activities reported as being carried out by the families of students in this band was ten, and the average number at school (weighted) was nine.

Although they lack sound knowledge about environmental issues, students in this band are far more likely to display a positive attitude towards tackling environmental problems, and feel they understand what needs to be done. By putting their faith in business and individuals, rather than governments, to make the necessary changes, they demonstrate a commitment to, rather than a rejection of, the capitalist economy and unhindered growth model of the developed world. A student in this band is described in the Environmental Literacy Scale as rejecting materialism and demonstrating a lack of faith in large-scale technology and continued economic growth, and this aspect of the description is problematic when attempting to align the results of the AELQ with the descriptive scale. Nonetheless, with their positive attitudes and commitment to action, these students are in many ways equipped to continue developing their knowledge and awareness of the scale and gravity of environmental and sustainability issues, and to be supportive of changes brought about by governments and business to that end.

Students with Highly Evolved Environmental Literacy

About one quarter (23.6%) of students in this survey have a *highly evolved* level of environmental literacy, with an average AELQ of 293, however, as would be expected

no student scored close to the maximum of 400. As with the concept of scientific literacy, students ideally leave school equipped with the skills and values necessary to increase their knowledge as opportunities and life experience allow.

Students at this level have a thorough understanding of how people and societies relate to each other and to natural systems, and an understanding of the dynamics of the environmental crisis, including an awareness of how societies have become so destructive. Such a student possesses an understanding of models of sustainability and understands and is able to act upon that knowledge in ways that lead to environmental sustainability and tend to rate their levels of interest, knowledge, commitment and action as medium to high.

Almost all of these students either entirely or mostly sure that the planet is warming and the climate changing (98%), that human activity is the main cause (93%), burning of fossil fuels the main source of greenhouse gases (95%) and that the climate will change dramatically in their lifetime (95%). 50% of these students were entirely or mostly sure that Australia is overpopulated in terms of the carrying capacity of the environment, and 40% were entirely or mostly sure that there was insufficient water for our future needs. In fifteen of the other questions on the Knowledge scale 50% or more of students choose the correct response.

The attitude of students with highly evolved environmental literacy was more positive than the students in the bands below them. They agreed that sustainability issues and the environment were often talked about at their school (67%), although they felt the issues did matter to their teachers (89%), and that they cared that their students understood them (89%). They felt that sustainability issues and the environment were less often talked about at their family (58%), but that the issues mattered to their parents (86%), and that they cared that their children understood them (86%). This is a striking contrast to the results for the same question in the lower bands, clearly indicating that students with highly evolved environmental literacy feel that environmental matters are important to their teachers and parents, and that it matters to these role models that the students also understand these issues.

In terms of questions from the Awareness Scale, these students agree they are interested in what they learn about the environment (95%), that they learn a lot about environmental issues at school (81%), and that what they learn worries them (95%), but that they feel they can learn what they can do to solve the problems (91%). They feel their main source of information is school, followed by the media, and rate them highly; most saying they receive 'lots' and 'some' of their information this way. They get 'some' of their information from their families, but 'very little' from their friends.

They overwhelmingly agree (97%) that individuals have a role to play in tackling environmental issues, but place the role of businesses (99%) above that of government (54%) in tackling the problems. The majority (99%) of these students express a positive attitude towards their role in tackling these problems, and they feel they understand the sorts of behaviours they can do to help (97%). Though they have faith in the positive benefits of science and technology (97%), 79% of them do not think environmental problems will be sorted out in time for them to *not* have to worry; indeed 53% think science and technology make our way of life change too fast. When asked to assess the risk of a range of environmental issues, a third or more of these students were able to correctly identify them.

The average number of activities reported as being carried out by the families of students in this band was thirteen, and the average number at school (weighted) was also thirteen.

Although they are still acquiring deep knowledge about environmental issues, students in this band are most likely to display a positive attitude towards tackling environmental problems, and feel they understand what needs to be done. They notice that their teachers and parents feel that environmental issues are important, and they realise that the adults in their lives expect them to understand these crises. These students are still inclined to put expect business and individuals, rather than governments, to take a leading role make the necessary changes. A student in this band is described in the Environmental Literacy Scale as demonstrating a passionate and committed belief in the production of an environmentally literate, committed and active citizenry, which was not

measured in this survey, and indeed might be difficult to measure. Nonetheless, with their positive attitudes and commitment to action, and their well-developed knowledge and awareness of the scale and gravity of environmental and sustainability issues, these students are likely to continue to develop their level of environmental literacy and to be engaged with and supportive of changes brought about by governments and business in the future.

Table 6.28

Descriptive Results of Each Band within the AELQ - Knowledge Scale

	Illiterate		**Nominal**		**Functional**		**Highly Evolved**		**Combined**	
Question	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**
6a	2.0	n.a.	2.8	62.4	3.4	92.8	3.7	98.3	3.4	90.6
6b	2.0	n.a.	2.4	45.2	3.0	80.6	3.4	92.6	3.1	79.2
6c	2.0	n.a.	3.0	68.8	3.5	91.2	3.8	96.6	3.5	89.8
6d	2.0	n.a.	2.5	49.5	3.0	78.3	3.4	94.9	3.0	78.6
6e	2.0	n.a.	2.5	51.6	3.0	79.6	3.5	94.9	3.1	79.7
6f	2.0	n.a.	1.8	21.5	2.1	41.0	2.3	50.3	2.1	40.8
6g	3.0	n.a.	2.5	51.6	2.5	43.3	2.5	40.0	2.5	43.7
10a	0.0	n.a.	0.5	17.2	1.1	45.6	1.5	64.6	1.2	46.4
10b	0.0	n.a.	0.5	18.3	1.1	43.1	1.4	57.1	1.1	43.3
10c	2.0	n.a.	0.6	22.6	1.0	31.0	1.2	38.9	1.0	31.8
11	0.0	n.a.	0.5	10.8	1.0	44.5	1.4	64.6	1.1	45.0
12	0.0	n.a.	0.8	25.8	1.1	39.3	1.3	46.9	1.1	39.4
13	0.0	n.a.	0.3	5.4	0.6	12.5	0.9	22.9	0.7	13.9
14	0.0	n.a.	0.5	20.4	1.4	64.6	1.7	80.6	1.4	63.0
15	0.0	n.a.	0.4	8.6	0.9	26.9	1.2	38.3	0.9	27.3
16	0.0	n.a.	0.2	5.4	0.5	7.9	0.7	10.9	0.5	8.3

	Illiterate		Nominal		Functional		Highly Evolved		Combined	
Question	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**
17	0.0	n.a.	0.5	12.9	1.2	43.7	1.5	61.1	1.1	43.9
18	0.0	n.a.	0.4	7.5	0.7	10.6	0.9	14.9	0.7	11.1
19	0.0	n.a.	0.7	23.7	1.4	59.9	1.8	80.0	1.4	60.0
20	0.0	n.a.	0.2	6.5	0.5	11.1	0.6	11.4	0.5	10.6
21	0.0	n.a.	0.3	5.4	0.8	12.5	1.0	23.4	0.8	14.0
22	0.0	n.a.	0.5	20.4	1.3	54.4	1.5	68.6	1.2	53.6
23	0.0	n.a.	0.3	5.4	0.9	20.6	1.2	30.3	0.9	20.9
24a	0.0	n.a.	0.8	31.2	1.5	69.4	1.7	79.4	1.5	67.2
24b	0.0	n.a.	0.7	28.0	1.6	75.5	1.8	85.1	1.6	72.2
24c	0.0	n.a.	0.5	18.3	1.3	56.7	1.7	76.0	1.3	56.5
24d	0.0	n.a.	0.7	33.3	1.6	73.8	1.8	84.6	1.5	71.5
24e	0.0	n.a.	0.3	8.6	1.1	37.0	1.4	57.1	1.0	38.0
24f	0.0	n.a.	0.5	23.7	1.3	60.0	1.6	77.1	1.3	59.6
24g	0.0	n.a.	0.3	12.9	0.8	30.3	1.2	51.4	0.8	32.8
24h	0.0	n.a.	0.36	23.7	1.3	54.4	1.6	70.3	1.3	54.3

Table 6.29

Descriptive Results of Each Band within the AELQ - Attitude Scale

	Illiterate		Nominal		Functional		Highly Evolved		Combined	
Question	**$\bar{X}$**	**% positive**	**$\bar{X}$**	**% positive**	**$\bar{X}$**	**% positive**	**$\bar{X}$**	**% positive**	**$\bar{X}$**	**% positive**
3a	2.0	n.a.	2.4	45.2	2.9	80.1	3.3	94.9	2.9	79.3
3b	3.0	n.a.	2.5	54.8	3.0	78.3	3.5	95.4	3.1	79.4
3c	2.0	n.a.	2.4	43.0	2.8	68.1	3.3	91.4	2.8	70.2
5d	1.0	n.a.	2.5	50.5	3.0	83.3	3.6	99.4	3.1	83.0
5e	1.0	n.a.	2.5	55.9	2.9	81.3	3.4	97.1	3.0	81.8
5h	1.0	n.a.	2.5	54.8	2.4	47.5	2.3	46.9	2.4	48.2
7a	2.0	n.a.	2.1	26.9	2.4	45.6	2.8	67.4	2.4	48.1
7b	2.0	n.a.	2.3	40.9	2.7	64.6	3.1	88.6	2.7	67.0
7c	2.0	n.a.	2.4	49.5	2.7	68.0	3.2	88.6	2.8	70.2
7d	2.0	n.a.	1.7	15.1	2.0	20.8	2.7	58.3	2.1	28.0
7e	2.0	n.a.	2.0	28.0	2.4	49.5	3.1	85.7	2.5	54.7
7f	2.0	n.a.	2.1	30.1	2.5	51.2	3.2	86.3	2.6	56.2

Table 6.30

Descriptive Results of Each Band within the AELQ - Awareness Scale

	Illiterate		Nominal		Functional		Highly Evolved		Combined	
Question	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**	**$\bar{X}$**	**% correct/ positive**
2a	1.0	n.a.	1.7	2.2	2.0	72.1	2.4	96.7	2.1	19.1
2b	2.0	n.a.	1.6	2.2	2.0	78.5	2.2	59.6	2.0	11.9
3d	1.0	n.a.	2.4	52.7	2.7	66.4	3.1	80.6	2.8	67.8
4a	1.0	n.a.	2.8	18.3	3.2	39.6	3.5	51.4	3.2	39.7
4b	3.0	n.a.	2.4	20.4	3.0	30.5	3.3	50.3	3.0	33.5
4c	1.0	n.a.	1.9	6.5	2.3	11.4	3.1	34.3	2.4	15.7
4d	1.0	n.a.	1.4	3.2	1.5	2.1	2.0	4.0	1.6	2.6
5a	1.0	n.a.	2.7	67.7	3.0	83.3	3.4	96.6	3.0	84.3
5b	4.0	n.a.	2.4	46.2	2.5	44.7	2.7	53.7	2.5	46.9
5c	3.0	n.a.	2.8	75.3	3.2	92.3	3.6	99.4	3.3	92.0
5f	4.0	n.a.	2.6	53.8	2.9	70.4	3.0	79.4	2.9	70.6
5g	1.0	n.a.	2.6	63.4	3.1	87.0	3.4	96.6	3.1	86.4
25a	0.0	n.a.	1.0	19.4	2.2	39.8	2.3	30.9	2.1	35.6
25b	0.0	n.a.	1.0	20.4	2.2	40.0	2.2	27.4	2.1	35.2
25c	0.0	n.a.	0.7	7.5	2.0	32.2	2.3	46.3	1.9	32.4
25d	0.0	n.a.	1.0	20.4	2.3	53.5	2.6	70.3	2.2	53.3
25e	0.0	n.a.	0.7	10.8	2.0	36.8	2.6	65.7	2.0	40.0
25f	0.0	n.a.	1.1	25.8	2.3	56.0	2.5	56.0	2.2	52.6
25g	0.0	n.a.	0.4	6.5	1.6	23.4	1.8	28.0	1.5	22.5

Table 6.31

Descriptive Results of Each Band within the AELQ – Action Scale

	Illiterate		Nominal		Functional		Highly Evolved		Combined	
Question	**$\bar{X}$**	**% correct**	**$\bar{X}$**	**% correct**	**$\bar{X}$**	**% correct**	**$\bar{X}$**	**% correct**	**$\bar{X}$**	**% correct**
2c	1.0	n.a.	1.8	11.2	2.0	62.2	2.4	49.7	2.1	23.4
2d	3.0	n.a.	1.6	6.7	1.6	52.1	2.0	16.6	1.7	7.9
8	3.0	n.a.	6.9	n.a.	9.7	n.a.	13.1	n.a.	10.1	n.a.
9	2.0	n.a.	5.9	n.a.	8.7	n.a.	13.2	n.a.	9.3	n.a.

6.7 Discussion of Reflections on the Method

Sample Selection

There are several limitations to the trends and relationships able to be determined from this thesis. Firstly, the sample of students surveyed is small. Because active consent must be sought for educational research in Australia, only those students who remember to give the consent form to their parents, and whose parents remember (or agree) to sign it, and those who remember to return the form to their teacher are included in the survey. Inevitably, the researcher arrives at the school to find students keen to participate with their peers, but who forgot the consent form.

Secondly, the schools asked to take part are those in close proximity to the researcher, and not a random selection of NSW schools. Just as passive consent is not used in Australian schools, there is no obligation on the part of any school to assist with educational research. A further subset to the sampling develops, in that only some schools agree to take part. Even after schools have agreed, some teachers expressed a tendency to only distribute forms to students they felt would reliably return the form and undertake the survey with serious intent. Additionally, in some high schools, some teachers within the faculty were more willing to assist than others.

These constraints mean that the sample is not random, and that any trends or relationships drawn from the data gathered need to recognise these limitations when conclusions are made. It is possible that the results are biased towards those schools with teachers who feel they are able to afford the time, those who habitually take it upon themselves to assist in educational research, and those with streamlined procedures for the distribution and collection of permission slips.

The difficulty in recruiting students to undertake the measuring instrument means that a very limited pilot study was able to be undertaken. As soon as the first group of students undertook the survey it was noted that question 14 did not have a clearly correct multiple-choice option, and that the questions were not ordered in greater degree of difficulty. The second issue was not of great consequence. The survey could not be altered without compromising the data and so the error was left to stand. During the data analysis, question 14 was discarded.

The survey was administered over a relatively short time span (late Term 2 to early Term 4), meaning that students were at a similar point in the academic year. It has already been pointed out that the nature of the two year Stages in NSW mean that students in one school may undertake a particular area of study at the beginning of Year 9, whilst at the neighbouring high school the same concepts may be studied in late Year 10. There was no way to reconcile this dilemma.

Measuring Instrument

A positive aspect of the survey process was the use of Survey Monkey as the means to administer the measuring instrument, as this meant that almost all surveys were fully completed; the survey being set up so that students could not move through the survey without selecting a response for each question. The exception to this was the format of questions 8 and 9, where students chose activities off a list. Some students did not answer these two questions, and a few ticked every box. Two students commented that they had only recently started at their school, and were not aware of any practices yet.

Upon reflection, these questions could have been improved, and students forced to complete them, if a different structure to the questions had been used. For example, students could read the statement 'my family recycles packaging and newspapers using the Council recycling bin' and choose from 'always', 'mostly', 'sometimes' and 'never'. Not only would this ensure all questions were completed, but would provide richer insights into the environmental activities carried out in the students' homes.

The list of environmental/sustainable practices in homes and schools could have been refined. No government school allows glass bottles, so the question of whether they are collected for recycling is a moot one and the response option proved unnecessary. This is not the case in non-government schools, but the options for glass bottles, aluminium cans and PET bottles could be collapsed into one option, when the survey is used in the future.

If the choices had been grouped differently, they could have allowed analysis of measures under different categories; for example, energy reduction, water saving, recycling and reuse. Students could also have been asked about the sustainable/environmental practices they carry out as individuals, rather than just what their family does. For example, one member of the family may walk or catch public transport to work, but if everyone else drives everywhere, trying to capture information about the family's footprint becomes more complicated.

A small number of students gave additional answers in question 8 and some other options suggested themselves once the survey process was underway. These included asking whether the family owned a hybrid vehicle, how many fridges the household had, whether the washing machine is front or top loader, if 'green' shopping bags are used, if carbon emissions are offset when flying, if the family has tried to decrease their meat consumption and if they re-use grey water. Students could also be asked if they knew which type of nappies their parents had used on them, if they knew whether their house had water efficient shower heads, if they used shower timers, bought E-10 petrol, used the plastics recycling code to identify recyclables, how often they used an air conditioner and if they kept chickens.

Some students commented on the difficulty of assessing the danger posed by the environmental issues presented in question 25. Intuitively, it seems that better informed students might actually 'over think' such questions. Most of the problems suggested came from the NSF survey, and were asked without much alteration to the wording. Nuclear power stations, as an example, are potentially very dangerous, but in reality and on a day-to-day basis, very low risk. A student who understands this might find it hard to choose between 'very dangerous' and 'somewhat dangerous'. Re-wording the questions to tease out the difference between danger and risk might have made a difference here. Other issues could also have been included, such as the shrinking gene pools of endangered species, or the logging of native forests.

Data Analysis

The problems which occurred with a small number of students during the completion of questions 8 and 9 have already been discussed. The responses of students who skipped these questions were analysed for the Knowledge, Attitude and Awareness scales, but removed from analysis of the Action scale and the overall AELQ. A few students were also found to have ticked every box in these two questions. These non-serious attempts were easily identified and were similarly removed from the data pool. A small number of students abandoned the survey part way through, and one or two had their computer crash during their survey. These too were removed before analysis commenced.

When assigning a value to the student's recognition of environmental practices in their school, correctly identified practices were counted but incorrectly identified ones were ignored. A student could identify eight practices at their school, for example, when only four actually occurred. They would score the same as a student who correctly identified the four activities, but made no errors in doing so. The scoring system used was not able to differentiate these nuances.

Content Validity

Content validity is a non-statistical type of validity that involves the degree to which the content of the measuring instrument matches the content associated with the construct

being measured. The questions in the measuring instrument have content validity in that they comprehensively reflect the concepts that are being measured. All questions link back to the NSW Science Syllabuses and use the terminology found in the syllabus documents, and therefore used by teachers in delivering the content. In addition, the test items were informed by similar measuring instruments used in other countries, thus ensuring a thorough examination of the subject domain occurred than might have if the instrument were only developed by the author of this thesis alone. The links between the questions, NSW Science Syllabus and similar measures of environmental literacy were outlined in Section 5.2.

Other Reflections

Miller (1998) has argued that open-ended items in the measurement of the public understanding of science yields better quality data. This was not possible in a study of this type, carried out single-handedly and without funds to support the extra effort required in data collection and coding. Further research using large, more random samples would do well to consider the inclusion of some open-ended items.

It would also be useful to study the changing nature of environmental literacy in students as they move through their years of formal schooling, to investigate whether the new National Curriculum, with its supposed underpinning of sustainability as a cross curricula theme, results in students whose environmental literacy matures as they do. It is important that students develop as high a level of eco-literacy as possible before their formal schooling ends, as Miller (1998) suggests that "individuals who have obtained a better understanding of science and technology through formal schooling tend to retain and enrich that understanding through the use of informal learning resources such as libraries, newspapers, magazines, television shows, and museums" (p. 220).

As mentioned in Chapter 1, the United Nations Conference on Environment and Development stated that "education is critical for promoting sustainable development and improving the capacity of the people to address environmental and developmental issues." (1992, Chapter 36). The type of education implied here is transformative, and

will bring about fundamental changes; including “the belief that each of us has both the power and the responsibility to effect positive change on a global scale” (UNESCO, 2004, p. 17).

This leads to the broader question of how an individual develops their belief systems, and how these may, or may not change over time. How to address the stubborn ability of humans to remain fixated on short term and self-interested thinking in the face of global environmental challenges is one of the greatest dilemmas facing humankind. Does a highly evolved environmental literacy level mitigate such behaviours? As Miller says, “most of the interesting questions about human behavior involve some understanding of the origins and sources of change, and the best measures of change will ultimately be obtained by measuring the same individuals periodically over some span of time” (p. 200).

CHAPTER 7

CONCLUSIONS AND IMPLICATIONS OF THE STUDY

This section will reiterate the conclusions related to the five research questions that guided this study and present a discussion of these findings. The purpose of this study was to measure the environmental literacy of NSW school students in Stages 3 to 5 by assessing the environmental content of the NSW Science syllabuses and the impact of the environmental and sustainability cultures of the school and the home. The research hypothesis was that NSW students are not developing sufficient levels of environmentally literacy to prepare them as citizens concerned about a sustainable future, and that the influence of the home environment plays a greater role in developing environmental literacy than the school culture.

There are no definitive qualitative standards or norms for environmental literacy yet available, and the conclusions of this study must be understood within this context.

7.1 Results and Conclusions

An instrument, the *Australian Environmental Literacy Quotient* (AELQ), was developed that measures four different dimensions (Knowledge, Awareness, Attitude and Action) using 66 items and three demographic variables. The AELQ was completed by a total of 836 students from five primary and five secondary NSW schools in outer metropolitan and regional areas. It is believed that no other attempt has been undertaken to quantitatively evaluate the environmental literacy of Australian students.

Cronbach's alpha was applied to examine the reliability of the Attitude and Awareness scales. In this analysis, a value of one indicates that the questions are different forms of the same question (i.e., entirely consistent) and a value of zero indicates that the questions have no relation to each other (i.e., entirely inconsistent). Thus, the higher the value of this coefficient, the better the internal consistency, and the better the instrument is in measuring what it was intended to measure. Generally, an alpha coefficient of greater than 0.6 is considered acceptable for initial investigations (Nunnally, 1978). The

Cronbach alpha reliability coefficients of the scales were 0.75 for Attitude (five items), and 0.77 for Awareness (eight items), confirming that the scales can be used with confidence in studies of environmental literacy.

Environmental Knowledge was measured in 31 items with a possible raw score of 76; with a Stage 3 mean score of 41.7, a Stage 4 mean score of 44.6 and a Stage 5 mean score of 47.3. Awareness of environmental issues was measured with 19 items with a possible raw score of 67. The Stage 3 mean score was 47.7, the Stage 4 mean score was 45.0 and the Stage 5 mean score was 45.3. Attitudes towards sustainability issues were measured with 12 items with a possible score of 48. The Stage 3 mean score was 36.9, the Stage 4 mean score was 32.0 and the Stage 5 mean score was 31.4. The number of environmental behaviours practiced at home and school that the student could name was measured in the four Action items, with a possible raw score of 40. The Stage 3 mean score was 26.0, the Stage 4 mean score was 23.3 and the Stage 5 mean score was 22.2. The results show that older students in Stage 5 had higher means than Stages 3 and 4 on Knowledge and Awareness, while Stage 3 students had higher means on Attitude and Action.

Cognitive knowledge was shown to develop over time, with students in Stage 5 having acquired slightly more environmental knowledge than students in Stage 3. However, student scores were, on average, higher on the Awareness Scale than on the Knowledge Scale suggesting that students were more aware of, than equipped with, knowledge about environmental and sustainability issues.

Younger students scored higher than students in Stages 4 and 5 on the Awareness Scale, so while the differences are relatively small, they suggest that Stage 5 students are more knowledgeable, but that high students are less aware than students in primary school of environmental and sustainability issues.

Similarly, on the action-orientated scales, student scores were, on average, higher on the Attitude Scale than on the Action Scale, although on average Stage 5 students scored lower than Stage 3 and 4 students on these scales. These results indicate that the

intentions of students were more positive than the sum of their actions, with older students having less positive attitudes towards understanding and tackling environmental and sustainability issues, and being less likely to take action.

To assess whether students' environmental knowledge, awareness, attitude and actions were related, a correlation matrix was generated. The results of the study indicate that the correlation between knowledge and awareness is the strongest, while that between knowledge and behaviour is the weakest. Environmental knowledge was determined to be related to awareness of environmental issues, but the value of the correlation coefficient was low (r = 0.56). Similarly, a slight correlation was found between the environmental awareness and attitude (r = 0.53) scores. The weakest correlations were found between students' knowledge and level of action (r = 0.23). Overall, correlations showed that there were relationships between students' awareness of environmental issues, their knowledge of environmental issues and their positive attitude towards tackling environmental issues and practicing sustainable behaviours.

Despite Bolstad, Baker, Barker, and Keown (2004) stating that whole-school approaches as the best way to support the goals and aims of EE, the findings of this study indicate that there is not a strong link between the environmental practices of a school and either the positive attitude or the level of environmental literacy of students. The study found that the correlation between the environmental practices of the school and the environmental literacy of the students was low (r = 0.52). It was found that the attitude of parents and the sustainable behaviours practiced in the home had a slightly great impact on a student's environmental literacy level (r = 0.59). These findings support the research hypothesis. When comparing the environmental practices in the home or the school against the AELQ Stage 3 students to have a higher degree of correlation, than Stage 4 students, who in turn had a higher level of correlation than Stage 5 students.

An *Australian Environmental Literacy Quotient* (AELQ) was obtaining by compiling the four components of environmental literacy scores, each Scale score weighted to a score out of 100, thus giving a total score out of 400. The range was divided into four

bands, based on the body of literature, particularly the descriptive Scale of Environmental Literacy developed by O'Riordan (1981), Roth (1992), Orr (1990, 1992) and Bybee (1997). The bands described environmental illiteracy (0-124), nominal environmental literacy (125-199), functional environmental literacy (200-274) and highly evolved environmental literacy (275-400). The scores ranged from 123 to 339, with the Stage 3 composite score being 264, while Stage 4 and 5 both had composite scores of 245. 11 percent of students had nominal literacy, 67 percent we found to be functional and 22 percent had highly evolved environmental literacy.

Additional insight into environmental literacy was gained from examining the scores associated with the four components of environmental literacy included in the measuring instrument used in this research. Of the four scales, the highest scores for all stages were attained in the Awareness Scale with a Grand Mean (combined Stages 3, 4 and 5) of 68.4 and means of 70.4, 67.1 and 67.5 for Stages 3, 4 and 5, respectively. The range for the Awareness Scale was 38-94 with a range of basic (28-75), functional (33-89) and highly evolved (66-91). Slightly lower scores were obtained in the Attitude Scale, with a Grand Mean of 67.4 and means of 76.4, 66.7 and 65.3 for Stages 3, 4 and 5, respectively. The range for the Attitude Scale was 28-91 with a range of nominal (40-73), functional (38-90) and highly evolved (54-94).

The scores obtained in the Knowledge Scale resulted in a Grand Mean 61.1 and means of 56.0, 58.7 and 62.2 for Stages 3, 4 and 5, respectively. The range for the Knowledge Scale was 18-91 with a range of basic (18-74), functional (20-91) and highly evolved (47-89), while the lowest scores were found in the Action Scale with the Grand Mean of 50.5, with means of 61.0, 50.7 and 48.3 for Stages 3, 4 and 5, respectively. The range for the Action Scale was 14-93 with a range of nominal (14-59), functional (17-80) and highly evolved (35-93).

In the scores for components that asked students to demonstrate knowledge or skills the Stage 5 students outperformed Stage 4 and Stage 3 students. This would be expected due to developmental differences as the students mature and the amount of content covered in the years between Year 5 and Year 10. In the components that relied on self-

reporting of actions and attitudes Stage 3 students outscored the older students, although the majority of students of all ages reported high levels of interest and concern around environmental issues, and most students felt empowered to take the appropriate actions. Although there are differences within the bands of environmental literacy, this study found that students with the highest environmental literacy had the highest levels of knowledge; the most positive attitudes; the greatest awareness; and carried out the greatest number of sustainable behaviours.

Based on these findings, this measuring instrument is useful for understanding the ways in which students know about the environment; issues of sustainability, such as climate change and resource use; and the values and attitudes they have developed.

Some of the conclusions from this study broadly concur with findings in other overseas studies, but without a common measuring instrument only tentative conclusions can be drawn about the relative environmental literacy level of NSW students, compared to students elsewhere. It is anticipated that the results of this study could become the basis against which future assessments could be compared.

7.2 Implications for Schools

This study found that students were generally not aware of all the sustainable practices carried out by their school. All the schools in the survey had implemented some sustainable practices. The most common were the installation of water tanks, collecting scrap paper for recycling and having a kitchen garden, while the least common ones were collecting food and drink packaging for recycling, and participating in environmental programs. The momentum of the environmental programs of the early 1990s seems to have stalled, with some practices, such as water tanks, being taken up by most schools, while other activities have fallen by the wayside. It is not enough for schools to form a committee, write an environmental management plan and have its goals peter out over time as busy teachers turn their attentions elsewhere. The mandated need to write a School Environmental Management Plan (SEMP) does not mean the SEMP is ever followed through, audited and updated. The opportunities for schools to

reduce their ecological footprint, saving money as well as modeling best practice, are still manifold.

This study has shed light on the development of students' understanding of environmental issues as they move from primary to secondary school, leading to a greater understanding of when environmental literacy develops. Since there are clear indications that the positive attitudes and levels of action of younger students diminish over time students must enter high school with strongly positive attitudes and actions towards environmental and sustainability issues. Primary schools are well placed to educate parents, as well as students, on the importance of positive environmental values and practices although, as with any values and behaviours modelled at school, the home environment is the dominant determinant.

Levels of knowledge and awareness around environmental issues were shown to be higher in high school students, although the differences were not as great as might be expected. Indeed, environmental literacy seems to be well established by the end of primary school, especially in relation to positive values and attitudes towards the environment. This suggests the limited amount of content about environmental and sustainability issues in the NSW Science syllabus is not sufficient to develop high levels of environmental literacy in students, which supports the research hypothesis.

More informal ways of learning about the environment, such as kitchen gardens, keeping chickens, participating in environmental clean-ups and tree plantings seem to have resonated with the students who undertook the survey, and provide a clue as to the types of learning experiences that might kick start positive attitudes and actions. If teachers are able to utilise the opportunity provided in the National Curriculum to use sustainability as a consistent and coherent theme in their science programs then some of the pedagogical approaches associated with the emerging paradigm of Education for Sustainable Development might find their way into Australian classrooms.

The findings of this study suggest that the attitudinal and awareness aspects of environmental literacy have been reasonably well developed in students, but that this has

not been translated in to actions, and that most students lack the knowledge and a thorough understanding of environmental issues that they will need if they are to leave school with more than functional levels of environmental literacy.

7.3 Implications for Teacher Training

Although this study did not measure the environmental literacy of teachers, none of the primary or science teachers involved in this study was aware of the Decade of Education for Sustainable Development. Some were not cognisant that sustainability is one of the three themes underpinning the new National Curriculum. This was consistent with the findings of Cutter (2001), who concluded that primary school teachers are probably functioning at a level of environmental illiteracy and/or nominal environmental literacy.

It is worrying that at present it seems unlikely that the teacher training system will produce teachers who can nurture an environmentally literate citizenry. Interest in environmental and sustainability issues still appears to be a matter of personal interest or conviction for teachers, rather than a key raison d'être. Hopefully the notion of sustainability will percolate into the consciousness of teachers as they begin the process of programing and teaching the new curriculum, and the after-effects of the Decade of Education for Sustainable development will gradually find their way into educational practice.

7.4 Implications for Further Research

This study provides a gateway to more in-depth research by providing baseline data about the level of Australian students' environmental knowledge, attitudes, awareness and actions.

Further research could refine the AELQ, by carrying a large pilot study to compare the environmental literacy of students in various states and territories and determine which questions are most relevant in terms of the information they elicit. It would also be valuable to study how students develop their environmental literacy over time, especially as the new National Curriculum is adopted.

Such enquiries could provide data that could assist in refining the curriculum. Research could also be undertaken to identify which factors (e.g., socio-economic status, educational level of parents and students, or cultural) may contribute to the disparities found across the variables measured by the AELQ.

7.5 Conclusion

The DESD may be at an end, but the vision that a quality education can teach the values, behaviour and lifestyles required for a sustainable future remains as important as it did in 2002, when the Decade was first proclaimed. ESD is for everyone, at all stages of life and in all possible learning contexts, but it is young Australians who will be tackling the serious implications of environmental challenges such as climate change, species loss and water and energy shortages in just a few years. Education, particularly science education, has a vital role to play in developing the knowledge, values and skills necessary to develop a level of environmental literacy in students that will allow them, as adults, take part in decisions to improve the quality of life and maintain environmental sustainability, both locally and globally.

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APPENDIX A – Consent Form

Curtin University of Technology

Science and Mathematics Education Centre

Participant Information Sheet

My name is Vanessa Smith. I am currently completing a piece of research for my Doctorate in Science Education at Curtin University of Technology

Purpose of Research

I am investigating the effectiveness of the NSW Science Syllabus in developing environmental literacy in students.

Your Child's Role

I am interested in finding out what level of environmental literacy your child has.

I would like to find out how much he/she understands about a range of environmental issues and how this affects attitudes and behaviour.

I will ask your child a series of questions about environmental issues. The questionnaire will be on-line and they will select their responses. It is not a test and the answers are neither right nor wrong, but they will give me a picture of how students think about what they have learnt in Science.

The questionnaire process will take approximately 10 minutes.

Consent to participate

Your child's involvement with this research is entirely voluntary. Your child has the right to withdraw at any stage without it affecting their rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to allow your child to participate and allow me to use their data in this research.

Confidentiality

The information provided will be kept separate from your personal details, and only I will have access to this. The questionnaire will not have your child's name or any other identifying information on it and in adherence to university policy, the transcribed information will be kept in a locked cabinet for five years, before it is destroyed.

Further information

This research has been reviewed and given approval by Curtin University of Technology Human Research Ethics Committee (Approval number SMEC-24-10). If you would like further information about the study, please feel free to contact me on 0402 209 131 or by email vanessa.j.smith@postgrad.curtin.edu.au. Alternatively, you can contact my supervisor Professor Darrell Fisher on 08 92663110 or D.Fisher@curtin.edu.au.

Thank you very much for your involvement in this research, your child's participation is important and is greatly appreciated.

Consent Form

Curtin University of Technology

- I understand the purpose and procedures of the study.
- I have been provided with the participant information sheet.
- I understand my child's involvement is voluntary and he/she can withdraw at any time without problem.
- I understand that no personal identifying information such as name and address will be used and that all information will be securely stored for 5 years before being destroyed.
- I have been given the opportunity to ask questions.
- I agree to allow my child to participate in the study outlined to me.

Child's name _____

Teacher _____

School _____

Signature of parent or guardian _____

Date _____

APPENDIX B – Survey Questions for Participants

1a.	What year are you in at school?		
Year 5 or 6	Year 7 or 8	Year 9 or 10	
1b.	I am a girl	I am a boy	
1c.	School ID letter		

How would you rate your personal response to environmental and sustainability issues?			
	high	medium	low
2a. My level of interest - I would rate how much I notice these issues as			
2b. My level of knowledge - I would rate how much I know about these issues as			
2c. My level of commitment to action - I would rate how much I want to help as			
2d. My level of actual action - I would rate how much I actually do as			

Think about the times in class when you have learnt about the environment….			
3a. I am interested in what I learn about the environment in class.			
strongly agree	agree	disagree	strongly disagree
3b. The things I learn make me worry about the future of the planet.			
strongly agree	agree	disagree	strongly disagree
3c. What I learn makes me think I can help protect and preserve the planet.			
strongly agree	agree	disagree	strongly disagree
3d. We learn quite a lot about environmental issues at school.			
strongly agree	agree	disagree	strongly disagree

This question asks you about where you get information about the environment. School, your family, media and friends are places you might learn about environmental issues. How much of your environmental information do you get from these sources?				
4a. From my school and teachers	Lots	Some	A bit	Very little
4b. From the media	Lots	Some	A bit	Very little
4c. From my family	Lots	Some	A bit	Very little
4d. From my friends	Lots	Some	A bit	Very little

These next questions ask you to rank how you think and feel about environmental issues, science and technology….

5a. I think individual actions have an impact on the environment.			
strongly agree	agree	disagree	strongly disagree

5b. I think it is mainly up to governments to make changes to help the environment.			
strongly agree	agree	disagree	strongly disagree

5c. I think companies and businesses should make changes to help the environment.			
strongly agree	agree	disagree	strongly disagree

5d. I would like to do as much as I can to help the environment.			
strongly agree	agree	disagree	strongly disagree

5e. I understand the sorts of things I can do in my day-to-day activities to help the environment.			
strongly agree	agree	disagree	strongly disagree

5f. I think they will sort it all out in time and I don't have to worry about environmental problems.			
strongly agree	agree	disagree	strongly disagree

5g. Because of science and technology, there will be more opportunities for my generation.			
strongly agree	agree	disagree	strongly disagree

5h. Science and technology makes our way of life change too fast.			
strongly agree	agree	disagree	strongly disagree

These questions ask you what you think about some environmental issues….			
6a. The planet is becoming warmer and the climate is changing.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6b. Human activity is the main reason for climate change (global warming).			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6c. The extinction of one species has an impact on other species.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6d. The burning of fossil fuels is the main source of greenhouse gases.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6e. Climate change will cause dramatic changes to the planet in my lifetime.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6f. There are more people living in Australia than our environment can handle.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.
6g. The way we use water in Australia means we will continue to have enough water for all our needs in the future.			
I'm sure of this.	I think so, but I'm not 100% sure.	I'm really confused and I don't know.	I don't think so.

Think about the people you know and their attitude to the environment…..			
7a. At my school we talk about sustainability issues and the environment a lot.			
strongly disagree	disagree	agree	strongly agree
7b. My teachers are concerned about the future of the environment.			
strongly disagree	disagree	agree	strongly agree
7c. It matters to my teachers that I understand environmental issues.			
strongly disagree	disagree	agree	strongly agree
7d. In my family we talk about sustainability issues and the environment a lot.			
strongly disagree	disagree	agree	strongly agree
7e. My parents are concerned about the future of the environment.			
strongly disagree	disagree	agree	strongly agree
7f. It matters to my parents that I understand environmental issues.			
strongly disagree	disagree	agree	strongly agree

Think about the things your family does in your home. Tick (✓) which activities your family carries out. Choose as many as you need to. If you aren't sure, don't tick that response.		
8.	**My family...**	
	collects rainwater for drinking or to use on the garden.	
	chooses to buy food grown locally.	
	generates solar power.	
	goes camping, bushwalking or does some other outdoor activity, at least once a year.	
	has a vegetable garden.	
	has a worm farm, compost bin or Bokashi bucket.	
	has (two button) dual flush toilets.	
	has energy efficient appliances.	
	has insulation in the roof, walls or under the floor.	
	has solar hot water.	
	recycles by using the council's bin.	
	recycles other things such as plastic bags, light bulbs, corks and mobile phones.	
	rides bicycles or walks instead of using the car so much.	
	took part in Earth Hour.	
	tries to minimise our water use.	
	turns lights off when we leave a room.	
	turns off electrical appliances when we aren’t using them.	
	collects rainwater for drinking or to use on the garden.	
	buys green power electricity.	
	uses public transport to get to work or school.	
	Other (please specify)	

Think about the environmental activities that go on in your school. Some of these activities might occur only once a year, while others may happen every day. Think about the activities for the school you go to now, not those you might have done at another school in the past.

Tick (✓) which activities your school carries out. Choose as many as you need to. If you aren't sure, don't tick that response.

9.	**My school…**	
	collects aluminum cans for recycling.	
	collects and composts food scraps.	
	collects glass bottles for recycling.	
	collects plastic drink bottles for recycling.	
	collects scrap paper for recycling.	
	has a kitchen garden (school veggie patch).	
	has solar panels on the roof.	
	has water tanks.	
	is a member of Streamwatch/Waterwatch.	
	is part of the Gould League.	
	keeps chickens or other livestock.	
	participates in Clean Up Australia Day.	
	takes part in National Threatened Species Day.	
	takes part in National Tree Planting Day.	
	takes part in Walk To School Day.	
	takes part in Wastewatch.	
	uses recycled paper for worksheets.	
	Other (please specify)	

These questions are about some things you might have studied in school. Some of these ideas you may not have covered yet. You are not being marked on this test, so please don't guess. If you don't know, it is OK to say so.

This question asks you how long you think the world-wide supply of fossil fuels will last. For each type of fuel, choose the time you think is most correct.

10a. Coal

5 - 10 years	50 - 200 years	500 + years	Don't know

10b. Crude Oil (petrol, kerosene)

5 - 10 years	50 - 200 years	500 + years	Don't know

10c. Natural Gas

5 - 10 years	50 - 200 years	500 + years	Don't know

11. Which property of water is most important for living things?

A. It does not conduct electricity

B. It is liquid at most temperatures on Earth

C. It is odourless

D. It is tasteless

E. Don't know

12. Which one is a producer?

A. Eucalyptus tree

B. Fungi

C. Human

D. Tiger

E. Don't know

13. The atmosphere is made up of about 21% oxygen and 78% nitrogen.

A. About 0.004 %

B. About 0.04 %

C. About 0.4 %

D. About 4 %

E. Don’t know

14. Which gas do most scientists believe causes temperatures in the atmosphere to rise?

A. Carbon dioxide

B. Helium

C. Hydrogen

D. Oxygen

E. Don’t know

15. What energy source used by humans contributes the most carbon dioxide to the atmosphere?

A. Coal

B. Natural gas (methane)

C. Nuclear power

D. Petroleum (petrol)

E. Don’t know

16. According to data collected by climate scientists, how many of the ten hottest years on record

A. zero

B. one

C. five

D. nine

E. Don’t know

17. Which country emits the greatest volume of carbon dioxide from human activities?

A. China

B. India

C. Japan

D. United States of America

E. Don’t know

18. Which country has the highest emissions of greenhouse gases per head of population?

A. Australia

B. China

C. Germany

D. United States of America

E. Don’t know

19.	Which method of cooking does not pollute the environment? A. Gas cooktop with natural gas as the fuel. C. Solar oven using the Sun's rays to cook food. D. Wood stove using wood or leaves as the fuel. E. Don’t know.
20.	About how many tons of carbon dioxide does the activities of the average Australian emit each A. 1 B. 5 C. 10 D. 20 E. Don’t know
21.	Which of these gases is NOT a greenhouse gas? A. Argon B. Methane C. Nitrous oxide D. Ozone E. Don’t know

22. Which of these is a likely consequence of climate change?

A. Biodiversity will increase.

B. Sea-levels will decrease.

C. The atmosphere will become colder.

D. The atmosphere will become hotter.

E. Don't know.

23. Which of these measures would **reduce** the levels of greenhouse gases in the atmosphere?

A. Building a plant (factory) to produce oxygen.

B. Increasing the amount of crops grown to make biofuels.

C. Planting trees on a massive scale.

D. Using more wind and solar power to generate electricity.

E. Don't know.

These questions ask you about some possible outcomes of climate change. For each one, tell me if you

24a.	Sea levels are predicted to rise by metres.	T	F	don't know
24b.	Australia's weather is unlikely to change.	T	F	don't know
24c.	More severe weather events (such as cyclones) are likely.	T	F	don't know
24d.	Average daily temperatures will not change.	T	F	don't know
24e.	Some countries will be underwater by the end of the	T	F	don't know
24f.	There will be more droughts in Australia.	T	F	don't know
24g.	The incidence of diseases such as malaria will increase.	T	F	don't know
24h.	Plants and animals will be able to quickly adapt to changes	T	F	don't know

These questions ask you about some environmental issues. For each one, tell me how dangerous you think the issue is. If you don't know, just choose that response.			
25a. Pollution of Australia's lakes, rivers, and streams.			
very dangerous	somewhat dangerous	not dangerous	I don't know
25b. Air pollution caused by industry (factories).			
very dangerous	somewhat dangerous	not dangerous	I don't know
25c. Pesticides, herbicides and other chemicals used in farming**.**			
very dangerous	somewhat dangerous	not dangerous	I don't know
25d. Nuclear power stations.			
very dangerous	somewhat dangerous	not dangerous	I don't know
25e. Rise in global temperature caused by climate change.			
very dangerous	somewhat dangerous	not dangerous	I don't know
25f. Air pollution caused by cars.			
very dangerous	somewhat dangerous	not dangerous	I don't know
25g. Modifying the genes of certain crops and animals (genetic engineering).			
very dangerous	somewhat dangerous	not dangerous	I don't know