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The Pedagogical Realisation of Education for Sustainability

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Abstract

The aim of this research was to investigate teachers' understandings of sustainability and ways in which they could be developed. How teachers translate these understandings into their pedagogy and its effects on children's understandings were explored. The impacts of learning about sustainability on teachers' identities were also investigated.

This research used a qualitative-interpretivist mode of inquiry with a case study approach that utilised a questionnaire and semi-structured interviews to answer the research questions that explored teacher participants' initial and developing understandings of sustainability during professional development. Two case studies describing and analysing practising teachers' translation of their understandings of sustainability into their pedagogy were constructed using interviews and documentary data that included planning and children's work. The final research focus explored the relationship between their understanding of sustainability and their sense of identity as education for sustainability (EfS) teachers.

A definition of sustainability comprised of five components was developed. Three tools were constructed to measure the complexity and levels of teachers' understandings and identities.The first tool measured the complexity of their understandings using the five-component definition. Initially these understandings were simplistic and environmentally focused. The second tool measured their metacognitive awareness of sustainability which showed that about half of the participants were unaware of the complexity of this concept. The findings established that this tool could be used metacognitively by teachers to monitor their developing awareness. The third tool provided a mechanism by which teachers' understanding and awareness of sustainability, personal practices and professional beliefs could be analysed to place the teachers in categories of identity that provided information about their outlook on sustainability. All of these tools provided evidence that the pedagogical realisation of education for sustainability is a complex process.

The professional development programme was thematically analysed and evaluated using a research-based generic model. Data from children's learning provided a further evaluation and demonstrated that a pedagogy that developed a deep understanding of sustainability is complex and is easily influenced by a teacher's identity and perception of sustainability. Consequently these teachers demonstrated their environmentally-scientific focus and these young children's understandings of sustainability did not reflect such a focus but they did develop a temporal awareness of sustainability.

This research has highlighted the significance of identity that influences ontological change in teaching and learning about sustainability and recognises that changes in behaviour and values of teachers are the lynch-pin of any significant change in classroom pedagogy for sustainability.

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Next I would like to thank the teachers with whom I worked. Thank you for allowing me to share the journey you took into teaching about sustainability in your classes. I know that you found incorporating sustainability somewhat daunting at the start but I hope that you now feel more confident and continue to incorporate sustainability into your programmes. My thanks also goes to the Principal who allowed me access to the school and the students in your classes that I interviewed. Thank you also to the student teachers who took part in my workshops. Your enthusiasm when taking part was inspiring and I hope that you use the ideas and workshop activities in your teaching.

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Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 The researcher's interest in the topic

Two factors have influenced my choice of research topic, that is my passion for the environment and the findings from my master's research project where I investigated the development of 11-12 year old students' understandings of sustainability (Birdsall, 2005).

I have always had an interest in conservation and the preservation of the natural environment for the future. My influences parallel the work of Chawla and her colleagues (Chawla & Cushing, 2007) in that I note that there are often significant experiences that can influence a person's attitudes towards the environment and lead to them taking action to protect it. Chawla and Cushing suggest examples that include childhood experiences of outdoor activities such as free play in the outdoors; camping and hiking; role models such as parents or teachers; and the witnessing of environmental degradation. I can identify with many of her examples, for instance playing in my neighbour's garden that seemed like a wilderness to a child, where my brothers, sisters and I played imaginary games and built huts. Mum used to take us all to the local stream to catch koura (native freshwater lobster) which I always wanted to take home to keep in an aquarium but my mother never let me. My family had yachting holidays (a floating form of camping) where I remember exploring rock pools and the small freshwater streams that flowed down hills and into the bays where we moored overnight. I also belonged to Girl Guides and recall going hiking in local bush areas and learning to identify native trees. We also learnt how to build campfires and I recall learning the skill of cutting back the turf before lighting the fire so that the grass wouldn't get damaged by the fire. Then, once the fire was out and cooled, you could fold back the turf so you couldn't even see where the fire had been.

During my adult life I have become more aware of what I can do to personally lighten my impact on the environment. I implement many sustainable practices such as trying to have one carless day a week, avoid use of plastic bags as much as possible as well as trying to reduce my waste and energy usage. My major on-going project is the restoration of my backyard which borders a local reserve area. This project involves eradicating the pest plants and re-planting the area with native flora in order to encourage the native fauna. In order to encourage native fauna I need to trap pest animals like possums. I really enjoy seeing and hearing the tui (native bird) as they swoop and dive around my house and the piwakawaka (fantail – another native bird) flit and dart through the branches of trees by my window. I regard myself as privileged to be able to sit at my dining room table and watch kereru (native wood pigeon) perch on the titoki tree just outside my window, after having gorged themselves on the berries from the nikau, karaka or puriri trees next to my house.

My personal environmental beliefs and values have also had an increasing influence on my professional life. As a classroom teacher, I had a passion for teaching science and always

included biology topics that contained a component examining the impact of human activities on the environment. As a lecturer, I introduce environmental themes into science education lectures to illustrate links that can be made in classroom programmes between science and education for sustainability for the student teachers. This professional perspective has been deepened as I have been responsible for the development of two education for sustainability courses in teacher education. When choosing a topic for my master's thesis, I chose to explore the development of children's understandings of sustainability.

I find the concept of sustainability intriguing. This single word can mean so much, or so little, depending on your point of view. For me, it embodies hope for our future. My interest in the concept of sustainability influenced my choice of topic for my master's thesis about the development of children's understandings of sustainability. However, researching this topic proved problematic because of the difficulty I had in finding a teacher who felt capable of teaching about sustainability. There appeared to be a paucity of teachers who felt confident to teach about sustainability. In the end, a colleague offered me her class to teach and research for my master's thesis. Consequently, I decided to continue research into this area by thinking of ways to develop teachers' confidence about the teaching of sustainability and providing material to support them in teaching this concept.

My initial plan was to design a series of professional development workshops to develop teachers' understandings about sustainability. I planned to invite students who were in the third year of their Bachelor of Education (Tchg) primary specialisation degree to participate so that I could follow their developing pedagogy for teaching sustainability during their first year of teaching. My plan was to collect their ideas about sustainability and then invite them to participate in a professional development opportunity. Once they won a job, I hoped to follow up this professional development with research into the translation of their understanding into their pedagogy. However, this plan did not eventuate and I had to explore other ways to answer my research questions.

The problem of how to find teachers who were willing to take part in my professional development programme intervention and research seemed to be a continuation of the problem encountered in my master's research. Fortunately for my project, but unfortunately for education for sustainability (hereinafter referred to as EfS), in 2009 New Zealand's government changed. The new right wing government did not need the Green Party with its environmentally focused policies to support its enactment of legislation. Therefore, this government has decided to place an extremely low emphasis on conservation and 'green' policies. An example of its low emphasis was the 2010 proposal to open up mining on conservation land that this government had previously protected from mining through legislation, claiming it would 'turbo-charge' the economy (Clifton, 2010). The public outcry and potential loss of votes in the next election did see them reversing this proposal (Clifton) but it does illustrate their environmental position.

Another of this government's election promises had dire implications for EfS because of a shift in Ministry funded professional development. In order to implement the promised system for the national monitoring of learning in literacy and numeracy, the new Minister of Education cut funding for professional development for teachers in the majority of learning areas, except for literacy and numeracy. Unfortunately this action has meant that most of the professional support for EfS in Auckland schools disappeared and left the Auckland Council as the only organisation supporting the implementation of EfS in its region's schools. As the only supporting agency, the Auckland Council is not able to provide support for every school wanting to implement EfS. Even though the introduction of a national standards system could be lowering the priority of implementing EfS in schools, Auckland Council still has a waiting list of schools wanting to introduce EfS into their curricula.

This lack of support worked to my advantage for this project. A colleague who knew of my problem, mentioned to me that they knew of a school wanting to incorporate sustainability into their school wide programmes but could not access any support and asked me if I would be willing to assist them. I saw this request as the answer to my problem. After discussions with the principal and the teacher in charge of EfS at the school, we came to an agreement that I could carry out my research and also assist the school in developing a school-wide EfS programme. In this way I was then able to continue my plan to investigate teachers' understandings of sustainability and how they translated their understandings into their pedagogy.

During the workshops, I became interested in the links between teachers' personal and professional lives. I wondered if their personal lifestyle decisions with reference to sustainability, such as taking re-usable bags to the supermarket, flowed through to their professional identity resulting in them having a passion for the teaching of EfS programmes.

Therefore, I decided to focus on exploring and developing student and practising teachers' understandings of sustainability, to investigate teachers' translation of their personal environmental beliefs into their EfS programmes and how this translation impacts on their children's learning. Because of my personal experiences, I decided to investigate the effect of their personal environmental beliefs on their identities as teachers as I wondered if their beliefs would influence their personal lives.

This proposed research seemed to have a place in the international EfS research spectrum. Two significant international reviews of literature have both identified the need for a deeper level of research into the processes and experiences of young people's environmental learning (Hart & Nolan, 1999; Rickinson, 2001). A more recent international review also highlighted the need for further research into learning processes but not just young people, but also practitioners of EfS (Reid & Scott, 2008).

1.2 My theoretical positioning on environmental issues and EfS

The previous section related to my personal and professional reasons for choice of topic, but I realised that I also needed a theoretical frame to justify my reasoning. My position could be regarded as being at one end of the continuum of thinking about environmental issues, where my views strongly support radical actions to promote sustainability, with my opinions and statements about these issues possibly verging on the polemic. However, to justify my position, I propose that these views can be supported by the literature on sustainability and EfS. Consequently, these ideas underpin my belief in the crucial role that EfS can play in reversing our downward spiral towards environmental collapse.

I developed my theoretical perspective as a result of trying to find out the reasons why we have reached a point where we seem to be facing the threat of catastrophic environmental collapse. There are a range of reasons put forward, such as there being too many people on our planet; maybe it's modern technology and industry (Stevenson, 2007a); or maybe it's the profligate developed countries that make up 20% of the Earth's population consuming over 80% of the resources (Nolet, 2009). However, these answers seemed to be simplistic answers to what is an extremely complex problem.

In this section I will firstly state my position about my opinions about why we are facing catastrophic environmental collapse and then discuss how I believe our current predicament has come about through the rise of capitalism and modernity. This section concludes with a discussion about possible ways forward that includes a possible outcome of the rise of a risk society in today's world (Beck, 1992).

My opinion is that people do not see themselves part of the nature. This dislocation from nature is at the heart of our current predicament. Instead people view themselves as separate from nature, viewing nature as the 'other' which is able to be used, managed and transformed without consequence. By 'nature', I am referring to the natural environment, both biotic and abiotic, the way in which resources are supplied and the systems needed to absorb the effects of our actions.

I believe that this position of separation from nature is flawed because nature plays an essential role in people's survival. According to Huckle (1996), a critical social theorist and self-confessed green socialist from the United Kingdom, nature is essential for people to produce the goods and services they need to survive as well as the continuation of this production. In order for a society to continue functioning, a stable supply of human labour, raw materials and technology is required, as well as the conditions to carry out production such as clean water and air and the raw materials from nature.

Over time, societies have been organised in different ways to carry out this production process. It is the social relationships between people in households or the workplace that reflect the patterns of ownership and control of the production process. Not only do these social relationships control the production process, they mediate people's relationship with nature through the use of

technology. For example, people living in cities are removed from the food gathering process and, because of the large amount of food needed for people living in cities, technology such as harvesting machinery and monocultural agricultural practices are used to augment the food production process. As a result, people are dislocated from food production processes.

It is important that people in these social relationships respect each other and acknowledge their interdependence. In other words, people have to be able to get along with each other so that the current forms of production and social reproduction, also known as political economy, can maintain human well-being and future survival (Huckle, 1996; Irwin, 2007). When a society is engaged in civil war and social relationships have disintegrated, there are devastating effects on the production process and consequently, on people.

I believe that people's dislocation from nature has arisen because of spread of particular economic and social organisations, namely capitalism and modernity, which have completely transformed production processes. The growth of different forms of capitalism and advent of modernity have resulted in a shift in people's perceptions of and relationship with nature which will now be discussed.

The rise of capitalism heralded the beginning of people's dislocation with nature because it brought profound changes to people's ideas about nature. With the end of feudalism and rise of capitalism, land became a commodity and a source of personal wealth. Its rise also saw the enclosure of common land along with the collapse of the institutions that maintained its cooperative use. The loss of common land paralleled the replacement of subsistence farming with factory-like farming for a market and nature became increasingly treated as a commodity. Since capitalism requires continual economic growth and has no built-in limits for maintaining the conditions needed for production (Huckle, 1996; Orr, 1994), I believe that ecological limits are now being reached. However, my radical views are probably to the fore when I express this opinion that limits have been reached or perhaps have been surpassed.

Capitalism enjoyed a long boom period from the end of World War Two up to the 1970s. However, this form of capitalism could no longer be maintained. At this time, the United States of America was losing its power to keep the world's economy stable. Costs of production were sky-rocketing and profits were falling and this resulted in economic stagnation. To overcome this stagnation, a re-structuring of the production process took place and a new type of capitalism emerged referred to as disorganised capitalism. Disorganised capitalism is associated with the rise of the new right, privatisation and deregulation. It has also seen an acceleration of globalisation with the redivision of labour on a global scale with the shift of production from developed to developing countries (Huckle, 1996).

Alongside the growth of capitalism has been the spread of a form of social organisation referred to as modernity. Modernity has had an effect on people's views of nature that I believe has also led to their dislocation from nature. Prior to the spread of modernity, people held an 'organic' worldview that regarded all living and non-living things, including people, as interconnected. The

Earth and cosmos were seen as living organisms. An example of this worldview can be found in the Maori concept of 'mauri' which is a form of energy found in the physical world, connecting and animating every living thing (Te Ahukaramu Charles Royal, 2009). Mauri is seen as an essential part of daily life because without it, mana or an "extraordinary power, essence or presence" (Te Ahukaramu Charles Royal, p. 1, para. 1) that enables Maori to experience the fullness of life, cannot flow into the world. An example of mauri in daily life is the use of sacred stones that possess mauri in fishing nets to attract fish. When fish are caught in the net, Maori people see not just fish, but the presence of energy within the fish. In this way, mana has arrived into the world through the arrival of Tangaroa, the god of the sea (Te Ahukaramu Charles Royal). This type of worldview of interconnectedness engendered respect for nature (Huckle, 1996).

Over the last three centuries there has been a shift to a worldview that is scientific and mechanistic, where the Earth and cosmos are seen as consisting of matter and energy. Scientists such as Galileo and philosophers like Descartes, took the stance that those things that could be quantified were more 'true' than those that could not be measured or counted (Orr, 1994). One result of this scientific perspective was that people were dislocated from nature and nature was seen as a machine to be transformed and managed to support people's interests. In this way a 'subtle sanction' was given for people's dominion over nature in pursuit of economic growth and wealth (Huckle, 1996; Orr). In effect a dichotomy was set up – that is culture against nature, with the construction of nature as the 'other' (Brickhouse, 2001). Sauvé (1999) agrees with this viewpoint and refers to this dislocation as a 'rupture' between people and nature. I agree with their perspective and believe that people have developed a 'selfish and utilitarian' relationship with nature where people take for granted that everything, whether a resource, service or even knowledge has a price that is set by the market (Irwin, 2007; Orr).

Huckle (1996) believes that there are now signs of a potential reconnection with nature due to a change in people's perceptions. These signs have come about because the advent of disorganised capitalism has seen the rise of an economy where knowledge is power and people's lives are full of uncertainty. As a result, people have become increasingly concerned about the quality of their life, about having to negotiate their way through uncertainty, both scientific and ideological, and having no clear borders between reality and image. An additional factor has been the threat of globalisation to the autonomy of nation states which further separates production from consumption.

As a result of these concerns, threats and uncertainties, Huckle (1996) asserts that people could be moving towards a moral view of nature that is concerned with justice and quality of life for all people. This view could result in establishing a closer link between people and the production process and could represent a shift away from the instrumental view promoted by modernity. I think that an illustration of this shift can be found in the resurgence in popularity of growing one's own vegetables. Many schools now have their own vegetable gardens. There are programmes available to support schools such as the Garden to Table Trust which acknowledges the disconnection between people and the production of food and its aim to reconnect people with

production of their food (Garden to Table, n.d.). In this programme children learn to create and care for a kitchen garden of edible food. When the vegetables are ready, the children harvest and prepare the vegetables for eating. In this way they not only are reconnected with the food production process but also learn healthy eating habits (Garden to Table). This example illustrates how such a potential shift could result in people's reconnection with the natural world and bring an end to our alienation from nature.

However, there is disagreement about how disorganised capitalism has affected people's connection with nature. Some people, such as Smith (2001) a Scottish environmentalist and sociologist, believe that the economic system of disorganised capitalism has resulted in people being even further dislocated from nature. He asserts that the uncertainty brought about by disorganised capitalism has resulted in a state of ephemerality which is characterised by disconnected images, symbols and values that are circulating at an every increasing speed with change itself as the only constant. Smith argues that people have been further disconnected from nature because nature has become part of these images and symbols, resulting in an abstract rather than tangible relationship. Examples of images promoting change that have an abstract relationship with nature can be found in advertisements that are constantly bombarding people, encouraging them to buy the latest version of a particular product, regardless of whether it is really needed or not. Often these advertisements are linked to images of nature in an attempt to confer legitimacy on the product because it 'helps' or else resembles nature in some way. A well-known example is the 'green police' advertisement created by the Audi car manufacturing company to promote its latest diesel SUV in 2010 (see http://www.youtube.com/watch?v=NxTNZUhesZk). Audi was promoting its new car as being a 'clean diesel' powered vehicle using images that could persuade people that purchasing and using their vehicle would be good for the environment. However, the fine particles in diesel exhaust have the highest cancer-causing risk of any toxic air contaminant (Office of Environmental Health Hazard Assessment, 2007), making the notion of 'clean diesel' an oxymoron. In this way people could think that they have a connection with nature, albeit abstract and tenuous but in actual fact, the dislocation between people and nature is being reinforced.

A different perspective to our potential reconnection with nature is provided by Beck, a German sociologist (1992). As a result of the threat of global destruction faced by today's society, Beck asserts that a new 'ecological labour movement' with a different relationship with nature could emerge.

The rise of this new labour movement could be the result of the way that today's global threats, accidents or events affect everyone. Beck (1992) refers to this phenomenon as living in a risk society. A risk society has come about because of the emergence and now dominance of "mega-technologies" (Beck, p. 98) such as nuclear power, genetic modification, nanotechnology and the threat of ecological destruction in the form of global warming. At no other time in our Earth's history has the threat of the destruction of everything on our planet been present. Beck argues that people's security has been seriously weakened because there is no way of providing a

guarantee of aftercare following accidents that involve these mega-technologies and no agency or government is prepared for a worst imaginable accident. Instead, he asserts that governments and agencies deny the dangers, and prefer to tout technological infallibility and use scientific evidence to support infallibility. Any questions about the possibility of accidents tend to end up in the "void of unpreparedness" (Beck, p. 101) to cope with such an accident's aftermath and so political stability is maintained through not thinking about such things (Beck).

This situation is different to past events, for example floods, because they came from outside of society and the cause could be attributed to the 'other'. Examples of other could be God, nature, demons, or groups of people perceived as different. Those people not affected could retreat behind this category. Today, any accident involving mega-technologies, or event such as an earthquake or volcanic eruption, affects not only the environment, but also the market and thus involves whole economic structures of nation states and global markets. As a result, new alliances of former class opponents (capital and labour) might be formed by the pressure of 'ecological politicisation'. This process is where people are able to reflect upon the effects of their choices on the environment and are then able to take political action that is motivated by their concern for the environment. According to Beck, an outcome of such political action could be the birth of an ecological labour movement. Therefore, according to Beck and Huckle (1996), there is cause for optimism for a reconnection with nature.

In summary, my opinion is that we are standing perilously close to a point where environmental collapse will take place. I believe that we have arrived at this point because of the way that economic and social organisations have resulted in our dislocation from nature and the production process. Consequently, many people have lost sight of how the products that they consume have been produced and the effects of that production process, including the disposal of products, on the environment. It seems to me that we have come to a point where everything is able to be defined in terms of a monetary amount that is set by the market, or the price someone is willing to pay for it. In addition, the economic organisation that has resulted in the globalisation of our world means that disasters that are caused by either natural events, such as earthquakes, or accidents that occur through our use of mega-technologies, affect everyone. I agree with Huckle (1996) and Beck (1992) that there are signs that people's values and behaviours might be changing and a reconnection with nature slowly being re-established.

I believe that we are all responsible for the care of our planet. My opinion stems from my belief that everyone is connected to nature in some way because we are all reliant on nature for survival and hence for the longevity of our society. Once we run out of resources that we need for survival, people as a species will become extinct. If every person is responsible, what can be done to help people reconnect with nature and make choices that will ensure not only a continued existence, but a satisfactory quality of life for all?

The United Nations Educational, Scientific and Cultural Organisation (UNESCO) regards formal education as one key strategy that can help people make such choices (UNESCO, 1997). This

type of education is known by various names such as ‘education for sustainability’ (EfS), ‘education for sustainable development’ (ESD) or ‘education for a sustainable future’ (ESF). Whatever the name, the focus is on developing and implementing an understanding of sustainability with the aim of improving the quality of life for all by addressing environmental issues, examining inequitable social structures and negative consequences of economic development (Tilbury, 1995).

Since formal education is regarded as a key strategy to changing people’s worldviews, it follows that teachers are significant agents of change because their role is to design and implement effective programmes of learning and then assess the results of such learning. When carrying out this role, they have the potential to influence the next generation’s skills and knowledge (Ferreira, Ryan & Tilbury, 2007; UNESCO, 2005). It is possible that, in order to carry out this role, teachers require both subject knowledge and pedagogical knowledge along with the skills to amalgamate these two types of knowledge together so that effective learning can take place in the classroom.

This educational process can be contextualised into EfS and is the major focus of this research: that is how teachers translate their knowledge about sustainability and incorporate it into their programmes of learning so that their students develop an understanding of this concept. Therefore, research questions were developed to explore the issues of teachers’ understandings of the concept of sustainability and the possibility of developing their understandings of sustainability; the ways in which teachers translate their understandings of sustainability into EfS programmes and the effects of such programmes on children’s learning, and how an understanding of sustainability can affect a teacher’s identity.

1.3 Outline of the thesis

The thesis contains eight chapters. My opinions and beliefs regarding our current environmental predicament and the important role of education in bringing about changes in people’s perceptions of and relationship with their environment were given in Chapter 1. My interest in the topic and justification for the focus of the research was described.

The second chapter discusses issues around defining the concept of sustainability such as its evolving, abstract and ambiguous nature. The components of sustainability are identified and their interrelationships discussed. Next a definition is provided that will be used as an analysis framework in this research project. Then the differences between the terms sustainability and sustainable development are discussed.

Chapter 3 continues the literature review, examining the current state of EfS in New Zealand schools including curriculum documents and professional development. Issues involved with measuring the effectiveness of professional development are discussed and a solution proposed through the use of a potential model. Next the role of sustainability in EfS programmes is examined along with a pedagogy that could help in developing an understanding of sustainability. The chapter also reviews literature about teachers’ ability to make subject knowledge accessible

to learners, or pedagogical context knowledge. Elements within pedagogical context knowledge that might explain how sustainability could be translated into pedagogy are discussed. Finally, the part that a teacher's sense of self, or identity plays in the way they develop and teach their EfS programmes is explored. This chapter also highlights opportunities for research in these areas.

The interpretivist methodology and research design are outlined in Chapter 4. The types and ways that the data were generated and analysed through thematic analysis are described. Three tools were developed to assist in data analysis and their construction is also discussed. A description of the participants involved is provided along with ethical considerations.

Chapters 5, 6 and 7 present the findings of my project. Chapter 5 presents the findings about student teachers' understandings of sustainability. Their self-ratings of their awareness of their understandings are analysed and compared with my ratings of their understandings using two analysis tools. Their identification of sustainability issues is discussed along with their sources of information about sustainability.

In Chapter 6 the development of the student teachers' understandings of sustainability are measured at the conclusion of the workshops along with their self-ratings of their awareness of their understandings using the same two analysis tools mentioned above. Their opinions about the most effective activity and most important thing they learnt are discussed. Their identities as teachers of EfS are analysed using another analysis tool developed for this purpose.

Chapter 7 consists of two interpretive stories about the way in which two practising teachers developed their understandings of sustainability and then translated it into their pedagogy. The issues they encountered in that translation process are discussed along with their perceptions of the success of their EfS programmes. The effects of their translation on their children's understandings of sustainability are discussed. How their understandings of sustainability affected their identities as EfS teachers is also outlined.

Finally, Chapter 8 concludes the thesis. A summary of the findings is given and discussed within the context of the literature. An evaluation of the professional development programme used is given together with suggestions to enhance the potential success of future professional development in EfS. The two major findings of this project are presented. This chapter concludes with implications for teacher education and suggestions for further research are offered.

Chapter 2: Sustainability: What Does It Mean for Education?

2.1 Introduction

> We are now using oil, gas and coal one million times faster than it is naturally replenished. There is no question that we will run out of it, whether in 50 or 100 years. If we persist at our present rate we will run out in two generations.

This prediction was made by Professor Hans Müller-Steinhagen (Rector of the University of Dresden and former chair of the Institute of Technical Thermodynamics of the German Aerospace Centre) during a visit to The University of Auckland in October 2010. Reported by Wilford (2011, p. 11), Müller-Steinhagen's statement is characteristic of many in the media that draw people's attention to our increasing use of non-renewable resources and the deterioration of our planet.

This thesis is about investigating a particular way of bringing about a change to people's awareness and consequent actions through education that will lead to a halt to the deterioration of our planet. Some people do appear to be trying to take action to slow down or halt our planet's degradation and a number of ways of bringing about such change have been proposed. One way is through inter-governmental policy-making which is a top-down approach. Another way is through education which is a more bottom-up approach.

Evidence of the top-down approach can be seen in the number of international governmental-level conferences that come to agreements about strategies for nations to adopt. For example, in November-December 2010 many world leaders met at the United Nations Climate Change Conference held in Cancun, Mexico to discuss the growing problems associated with the enhanced greenhouse effect and how agreement could be reached to halt and even reverse this phenomenon (United Nations Environment Programme [UNEP], 2010). The resulting publication, the *Cancun Agreements*, were regarded as a "balanced package of decisions" that will help governments in both the developed and developing worlds to reduce their carbon emissions (UNEP, p. 1, para. 1).

Inter-governmental agreements such as these can also influence educational directions and provide impetus for a bottom-up approach. Bolstad, Cowie and Eames (2004) note that changes to education with the goal of bringing about changes to people's environmental awareness and actions have been the subject of a series of international meetings and conferences that culminated in the United Nations Conference on Environment and Development or Earth Summit that was held in Rio de Janeiro in 1992. One of the documents produced at this summit was *Agenda 21*, which is a comprehensive action plan for all signatories at local, national and global levels (UN Department of Economic and Social Affairs, 2009). This action plan describes a multitude of strategies and initiatives to halt environmental degradation that could result in an

improvement to the quality of life for all (UN Department of Economic and Social Affairs). Chapter 36 of *Agenda 21* specifically refers to education, recognising it as one initiative with high potential to bring about change.

World leaders representing around 98% of the world's population, including New Zealand, were signatories to *Agenda 21* (Jucker, 2002). They pledged to develop national strategies to implement its goals, including education. Examples of such educational strategies included the study of environmental issues and the impact of human development in curriculum programmes at all educational levels; curriculum reviews to ensure a multi-disciplinary approach; provision of pre-service and in-service training for teachers, and every school receiving assistance to design work plans to implement teaching about the environment and development (UN Department of Economic and Social Affairs, 2009).

Unfortunately, little progress has been made in New Zealand to implement *Agenda 21*'s plans. Possible reasons for this lack of progress are suggested in a report written about New Zealand's contribution to the current UN Decade of Education for Sustainable Development (Chapman, Flaws & Le Heron, 2009). Its authors conclude that many policy statements that relate to the environment and sustainability are full of rhetoric but few concrete solutions. Furthermore there is a scarcity of programmes in schools or universities that promote education for sustainability (Chapman et al.).

As proposed earlier in this thesis (p. 8), education, both formal and informal, is seen as having strong potential for changing the types of decisions that people make about their lifestyles in order to take on the responsibility of decreasing environmental degradation (UNESCO, 2005). Both Hart (2007) and Stevenson (2006) agree with this stance and view formal education as a way of addressing the dislocation between people and nature by helping people to become aware of the effects that their actions have on their environment. However, while education is an essential element, education alone cannot bring about the type of changes required (Jucker, 2002). The responsibility for making these changes rests not only with individual citizens, but also with organisations and governments working together (UNESCO).

The idea of education bringing about change in society is not new and nor is it just found in calls for education about environmental issues. For example, although Freire's theory of education related to cultural emancipation, in that education is the "practice of liberty", he believed that empowering people through education would result in the development of critical consciousness (Freire, 1972, p. ix). Such critical consciousness could then empower people to change their relationship with nature. This premise is the same as the basis of EfS.

Cochran-Smith (2008) is an example of a contemporary educator who believes that education can bring about change in society through programmes for "education for social justice" (p. 1). In a similar manner to Freire, she argues that education for social justice is aimed at reducing the disparity of resource distribution among different groups in society and encouraging respect for all groups of people. She asserts that it involves both teachers and their students developing

awareness of the way that education involves issues of power as well as access to learning opportunities. Such educational access can then affect a person's opportunities during their lifetime (Cochran-Smith). Therefore, she argues that teaching and learning programmes must involve more than knowledge and skill development. Instead learning programmes need to become "justice-oriented citizen programmes" (p. 18) where attention is paid to where injustice is present, be it in the classroom, school, community or society. In this way, teachers and their students become advocates and activists, questioning the underlying structures of society and hopefully having the skills and desire to work towards bringing about change (Cochran-Smith).

Although education for social justice might not seem to be relevant to EfS, the two are linked in that both foci promote a change towards greater equity in society. Huckle (1991), writing from a critical perspective, argues that only through social democracy will resource distribution and use be adjusted in an equitable manner for all people so that they can move towards societies that function within Earth's carrying capacity. Thus one aim of EfS parallels education for social justice, that is to empower students to become aware of society's underlying power structures and to enable them to act as advocates of change in order to democratically change society (Tilbury & Cooke, 2005).

A contemporary science educator whose view of education parallels the aims of EfS is Derek Hodson. With a focus on science education, he also promotes a type of education concerned with equity and social justice (Hodson, 2011). Hodson argues that students need to develop a "critical scientific literacy" (p. 27), so that they are prepared to be responsible citizens who know how and are able to take action on scientific, technological and environmental issues. In a similar manner to that suggested by Cochran-Smith and the aims of EfS, Hodson proposes that students not only learn scientific knowledge and skills, but they need to question how scientific knowledge is constructed, and the power structures underpinning its privileged position. In addition, he suggests that students should question the power structures that underpin political and economic decision-making. Such education will enable students to develop understandings about socio-scientific issues, which include environmental issues, and then take considered action.

Because of the role that formal education can play in bringing about societal change, it is argued that teachers play a crucial role in education because they are key agents of such change (e.g. Cochran-Smith, 2008; Ferreira, Ryan & Tilbury, 2007; UNESCO, 2005). This key role is because they have the potential to bring about change within education systems through their implementation of curricula documents as well as being able to influence the understandings and skills of future generations of citizens (Stevenson, 2007b).

At present some educators believe that there is a problem with the world's education systems because they are currently "training our children to live in a world that cannot be sustained" and therefore, there needs to be a shift in focus to a type of education that will promote changed attitudes that could lead to the halting of environmental degradation (Sterling, 1996, p. 20). This need for change presents a paradoxical situation. How can education systems bring about

change in society when they are currently reproducing the values and structures of an unsustainable society? Sterling argues that in order to effect this change, education systems will need to be changed as well. UNESCO refers to this need for educational change as a reorientation of education, involving the teaching and learning of 'education for sustainability' (Tilbury, 1995) or EfS.

With the reorientation of education to education for sustainability, an understanding of the concept of sustainability is required so that people have the knowledge and possibly the motivation that they need to transform themselves into agents of change and believe that such change should be embedded into their lifestyle practices (Tilbury & Cooke, 2005). Therefore, this thesis proposes that developing an understanding of sustainability is important since it forms the basis of such change. Furthermore, this proposal is supported by the way that developing an understanding of sustainability is now regarded as a foundation for education for sustainability programmes (Nolet, 2009; Tilbury, 2004). However, developing an understanding of sustainability is challenging. Many people do not have a coherent understanding of what sustainability means (Jucker, 2002). This situation occurs even though Jucker asserts that the term is found in the annual reports of the vast majority of multinational corporations and, since the signing of *Agenda 21*, in the official documents of most countries. This problem of enabling people, and in particular teachers and their students, to develop an understanding of sustainability is the basis of this research.

2.1.1 Chapter structure

The chapter begins with an exploration of the challenges and issues associated with developing a definition of the concept of sustainability. The three components of sustainability are discussed in Section 2.3. It then presents a definition that is used within this project in Section 2.4. In Section 2.5 the difference between the two terms sustainability and sustainable development is explored. The first research question is then presented.

2.2 The challenges of defining sustainability: Issues of ambiguity and abstraction

This section discusses the challenges associated with defining sustainability and possible reasons for these difficulties are discussed. Developing an understanding of sustainability is important because having understanding could provide people with stronger reasoning to make changes to their lifestyles that could lessen their environmental impacts upon the Earth. As discussed before (p. 12), environmental educators argue that it is not just the responsibility of governments and organisations to change, it is individuals' responsibility too (Jucker, 2002; UNESCO, 2005). Consequently, it is important that teachers have an understanding of sustainability because teaching requires understanding of the content so that teachers can efficiently contextualise their pedagogical content knowledge (Shulman, 1986). However, despite the way that the word sustainability has gained currency over the last decade, many people are unable to offer a coherent description of this concept. Jucker, an environmental educator with a radical viewpoint, argues that due to their vague and superficial understanding, many people can be regarded as

eco-illiterate. Therefore, in support of this view and in order to foster the development of an understanding of sustainability, a definition of this concept that can be understood by the general population is required.

Arriving at a definition of sustainability is extremely challenging because of its contested and complex nature (Corney & Reid, 2007). It is a complex concept that has no single agreed upon meaning and so it can mean all things to all people (Summers, Corney & Childs, 2003). As a consequence people tend to find it "intuitively attractive" (Parliamentary Commissioner for the Environment [PCE], 2002, p. 31). There are many reasons for its complexity, namely: its evolution since its conception; its ambiguity and value-laden nature; its abstraction and consequent need for contextualisation, and the need for a temporal scale because of unforeseen consequences of decisions. The most recent issue that has arisen around defining sustainability is incorporation of the concept of resilience. Krasny, Lundholm and Plummer (2010) suggest that such incorporation could be a way of deepening people's understandings. The challenges associated with defining sustainability as well as the issue of incorporating resilience will now be discussed.

The first problem mentioned above that adds to the complexity of sustainability is the way that sustainability is an evolving concept (Fien & Tilbury, 2002). It is difficult to understand a concept when there is little agreement about its meaning and moreover, its meaning keeps changing. People's attention was first drawn to the concept in 1980 at the launch of the World Conservation Strategy (Fien & Tilbury) and then it was further emphasised with the publication of the report *Our Common Future* in 1987 (World Commission on Environment and Development [WCED], 1987). Here it was stated that: "humanity has the ability to make development sustainable – to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 8). This definition focuses on sustainable development and the notion of intergenerational equity.

Since then the meaning of sustainability has changed and now it is generally accepted that sustainability involves three components: the environment, society and the economy (e.g. Corney & Reid, 2007; Sterling, 2010). However, the configuration of and interrelationships between these three components are numerous. For example, Mann (2009) documented 255 diagrams representing sustainability in various configurations and acknowledged that there could be more. The latest contribution to this panoply of definitions is the incorporation of the concept of resilience as a framework that could lead to deeper understandings of the way in which the three components of sustainability interconnect (Plummer, 2010).

Another challenge with understanding sustainability is the ambiguity and value-laden nature of the concept that makes it difficult to develop a common definition. It seems that the very popularity and success of the use of the term sustainability can be explained in that it can mean all things to all people (Summers et al., 2003). As Selby (2006) notes, a count of sustainability definitions had already reached over 300 by 1996 and has probably further increased since then. Such

ambiguity then enables a wide range of different interest groups to each use their own interpretation, resulting a variety of viewpoints around any one issue (Fien & Tilbury, 2002; Stevenson, 2006).

Another factor leading to the difficulty of defining sustainability is that people's interpretations of sustainability are influenced by their personal values. Consequently, any interpretation of sustainability is value laden and can be classified as either an economic growth viewpoint or else a human development-environmental viewpoint. As a result, such an interpretation can be viewed along a continuum (Fien & Tilbury 2002; Sterling, 1996). At one end of this continuum is the economic growth viewpoint which prioritises sustainable economic growth and represents the dominant social paradigm. At the other end of this continuum is the human development-environmental viewpoint which prioritises sustainable human development and represents the new environmental paradigm.

The economic growth viewpoint end regards the growth of our present society as unlimited and views the environment in a utilitarian way with conservation seen as one of many policy options (Fien & Tilbury, 2002). This view is both technocentric and technocratic in that it encompasses the belief that scientific discoveries along with technological and economic tools will be used to move society towards more sustainable economic growth (Fien & Tilbury, Sterling). This viewpoint is reductionist and materialistic in nature and, according to Sterling, appears to represent a continuation of our untenable present path.

According to Fien and Tilbury (2002) and Sterling (1996), at the other end of the continuum is the human development-environmental viewpoint which calls for a deep-seated change to our current way of life. This viewpoint views growth as limited by the carrying capacity of our biosphere and seeks to change our current systems by focusing on democracy for all people; social equity with equal access to resources; as well as an awareness of ecological limits. The development of an ecologically literate society is also part of this paradigm. People who hold this viewpoint regard the physical world as an integrated whole rather than being separated into parts.

It has been argued that when making lifestyle decisions based on their definitions of sustainability, people's decisions can be located somewhere between these two points. An indicator of a person's values position could be reflected in their behaviour and choices. To put this continuum perspective into context, an example is when a person decides how they will travel to work in a city. If they choose to buy the latest 4x4 SUV, this person might regard their decision as sustainable because technological advances have resulted in cleaner burning fuels and greater fuel economy. However, because that person has chosen to drive alone, continuing to add to pollution and congestion, an analysis of the decision for this purchase using the continuum as a tool could place it near the economic growth viewpoint end.

Alternatively, this person might decide to purchase a hybrid petrol/electric car as a technological response to dwindling fuel resources. While this purchase would result in somewhat less fuel consumption and a decrease in air pollution, it is still one person using one car, still contributing to

pollution and congestion and therefore, analysing this decision could place it in the middle of the continuum. On the other hand, this person might decide to use public transport instead of a vehicle. An analysis of this decision using the continuum tool could place it near the new environmental paradigm end because it is a change in behaviour that would result in a relatively small per person amount of fuel consumed and little contribution to air pollution.

A further challenge with defining sustainability is the abstract nature of the concept. Viewing sustainability as three interrelated components does not help people to relate it to situations in their everyday life where they need to make sustainable decisions. Its abstract nature also presents a problem because many jobs require people to be able to make meaning of this concept, such as educators and people working in national and local government (Gough, 2002; Scott, 2001, Stevenson, 2007b). For example, people working in local government might be asked to formulate a sustainable transport policy for a city and so need to have some understanding of sustainability to construct such a policy.

Due to the challenges of abstraction and ambiguity, any definition of sustainability needs to be set in context to facilitate understanding. To illustrate the need for contextualisation, the sustainability of New Zealand's iconic Christmas tree, the pohutukawa, will now be discussed and the three interrelated components of sustainability identified.

The pohutukawa is commonly found along the coastline of New Zealand's North Island. In 1989 an investigation was carried out into the health of the pohutukawa (*Metrosideros excelsa*) by the Forest Research Institute (Project Crimson, 2009). It was found that more than 90% of New Zealand's coastal pohutukawa populations had disappeared due to the combined effects of people and the Australian common brush-tailed possum (*Trichosurus vulpecula*). The sustainability of populations of this iconic tree was in doubt and in order to halt its disappearance, the Department of Conservation in Northland (an environmental organisation – environmental component) and Carter Holt Harvey (a forestry industry-based company – economic component) designed Project Crimson, a community based project focused on bringing the pohutukawa back to the coastline. To date, many community and school groups (social component) have worked to successfully re-establish the pohutukawa (Project Crimson). This partnership provides a tangible illustration of the interconnectedness of sustainability's environmental, social and economic components with an industry company providing funding for an environmental organisation to organise community groups to revitalise the pohutukawa. Thus the sustainability of pohutukawa populations has improved and future generations of people are now more likely to be able to appreciate its bright red flowers in December. The flowering pohutukawa is representative of Christmas and summer to many New Zealanders and thus illustrates the cultural element contained within the social component (see p. 23). This example provides an illustration of the complexity of the three components of sustainability, their interrelationship and how they interact and intersect with people and their communities.

To further assist the general population to develop an understanding of sustainability, an environmental problem also needs to be set within a time scale or temporal component. By setting an issue within a temporal scale, people can appreciate that sustainability is a dynamic process, and is constantly changing over time (Plummer, 2010). Again the pohutukawa provides a contextualisation of the temporal component. Before European settlement, populations of pohutukawa were sustainable but with larger numbers of people, agricultural activity and the effects of introduced pests, the pohutukawa's continued existence was less viable. While this situation has been reversed and the pohutukawa is making a recovery on New Zealand's coastline, it is believed that people will never see stands of pohutukawa in their formerly large numbers again because it remains vulnerable (Project Crimson, 2009). Its vulnerability is due to a number of factors such as the large possum populations that ravage the trees as well as its roots being very sensitive and easily damaged by people, cars and cattle. The pohutukawa is also highly sensitive to fire and even lighting a fire alongside its roots beneath its branches can cause the death of a mature tree (Project Crimson). This account illustrates the temporal component of sustainability. As circumstances change, these changes can affect the pohutukawa's continued existence.

There is another important reason for incorporating the temporal component when defining sustainability. Including a temporal component also enables people to understand that there is no end point where sustainability is reached when considering an environmental issue. Even though some people regard sustainability as having an end point (e.g. PCE, 2004), there is a view that because our knowledge is limited, we can never be certain of the effects of our actions in the future. Consequently, this viewpoint considers sustainability as a dynamic process.

An example of limited knowledge and its unforeseen future effects is illustrated by the introduction of the pohutukawa to other countries, for example The United States and South Africa. In the mid 1980s about 5,000 pohutukawa were planted beside foothpaths in San Francisco to make the city more attractive and residents were very happy with their planting (Tapaleao, 2010). However, today San Franciscans' opinions of pohutukawa are the complete opposite. This total reversal has occurred because of limited knowledge and the unforeseen effects of their planting.

This issue has arisen because when the pohutukawa were planted, people either did not know or else did not consider what could happen as these trees matured. Now San Franciscans are faced with having to prune the pohutukawa regularly to prevent damage to power lines, repair the cracks to footpaths caused by roots and remove roots from blocked sewage pipes (Tapaleao, 2010). Even though the pohutukawa planting has been retrospectively acknowledged by an urban forestry expert to have been a mistake, it is very difficult for San Franciscans to have the trees removed from outside their residences. There is a strict process to be followed with a fine of US$2,000 for unauthorised removal (Tapaleao). Furthermore, in South Africa the pohutukawa has the status of being an invasive pest plant species (New Zealand Press Association [NZPA], 2006), and its South African status as a pest plant provides another example of the effects of limited knowledge and unforeseen effects.

This example of the pohutukawa illustrates the need to contextualise the components of sustainability in order to develop understanding of this concept. It also shows the way that limited knowledge and unforeseen effects impact on a person's understanding. The plight of the pohutukawa further reinforces the complex nature of sustainability in that while it is vulnerable in its native country, other countries have provided ideal ecosystems for it to flourish to the point where pohutukawa have come to be regarded as a pest plant species.

Finally, there is the issue of incorporating the concept of resilience. The incorporation of resilience is seen by some people such as Krasny et al. (2010) as having the potential to deepen the general population's understandings of sustainability. This need has come about because earlier definitions, such as the one found in *Our Common Future* (WCED, 1987), tended to focus on better management of the Earth and its resources through science and technology. Science and technology were also expected to provide the solutions to environmental problems. However, over the last twenty years there has been a growing realisation that better management of resources alone will not be able to solve our global environmental crisis. Additionally, we cannot expect scientists and technologists to provide all the solutions to environmental problems. New approaches will be required but exactly what form such approaches will take is uncertain. Hence a definition of sustainability that encompasses more than management and reliance on science and technology is now needed.

The addition of the concept of resilience to sustainability could have this potential because resilience involves ideas about people being able to cope with change and uncertainty. It also includes ideas such as seeing opportunities that come out of disturbances and the emergence of new paths or ways of thinking. Resilience is about species having the adaptive capacity to cope with change and uncertainty, and then being able to continue in such a way that is a "dynamic interplay between stability and change" (Plummer, 2010, p. 496). Therefore, the addition of these ideas to the concept of sustainability could help people understand sustainability as a dynamic process that is capable of adapting when faced with unexpected changes (Lundholm & Plummer, 2010).

The concept of ecological resilience originated with C. S. (Buzz) Holling (Plummer, 2010). His idea of ecological resilience has been claimed to have had a profound effect in both natural and social sciences and management of ecosystems (Stockholm Resilience Centre, 2007). Initially Holling proposed that resilience in ecological systems was the ability of the relationships within a system to absorb change and still endure. This view was a profound shift in thinking and challenged the previously accepted idea that ecological systems reached a state of equilibrium that is well ordered and stable, much like a well-oiled machine (Plummer, 2010; Selby, 2006). Holling then expanded this concept into a framework which includes the idea that ecosystems are "dynamic complex adaptive systems", meaning that an ecosystem has the ability to change as it adapts (Lundholm & Plummer, 2010, p. 481).

Although this concept was developed within the discipline of ecology, Plummer (2010) argues that resilience can be perceived as a metaphor that could help people to understand change and uncertainty in more general terms. The broadened use of the concept of resilience has come about because it was realised that other complex adaptive systems, such as societies, have properties similar to ecosystems. Consequently, applying the resilience concept could help develop understanding of the interactions between people and the environment, referred to as a socio-ecological system (Lundholm & Plummer, 2010).

Perceiving people and their interactions with the environment as socio-ecological complex adaptive systems and adding resilience to a definition of sustainability could then contribute to people's understandings of sustainability (Plummer, 2010). For example, people could gain deeper understandings about the interrelationships between the three components of sustainability (environmental, social and the economy) through their appreciation of the limited knowledge available and uncertainty of consequences of people's actions, resulting in an unknown future. A consequence of this understanding could be people realising the need to be flexible and open-minded which could then assist them to cope with changes in their lives. However, incorporating the resilience concept also presents problems of ambiguity and abstraction similar to those discussed when defining sustainability (pp. 15-7). Because both resilience and sustainability are abstract and theoretical concepts, they can appear meaningless to the general population, but when explained within a context and temporal scale, people are able to gain a deeper level of understanding resilience (Plummer, 2010).

Despite these challenges around defining sustainability and the issue of resilience, there is one point of agreement when defining sustainability. The agreement is that sustainability is made up of three interrelated components, namely environmental, society and the economy. This point of agreement will be discussed in the next section.

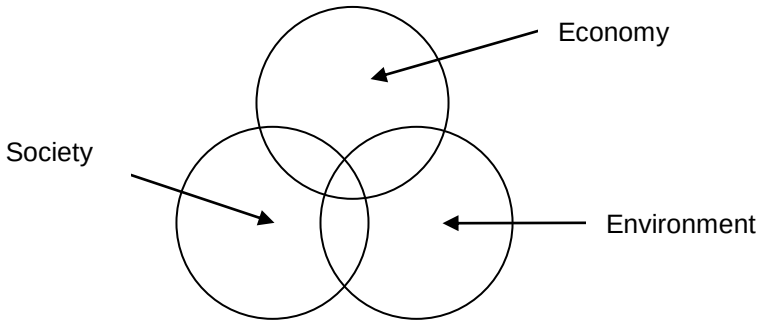
2.3 Sustainability: Its components and interrelationships

Many environmental educators agree that sustainability is comprised of three components: the environment; society and our economic system (Corney & Reid, 2007; Gough, 2002; Nolet, 2009; Sterling, 2010). Furthermore, it is argued that these three components are interconnected systems and cannot be separated (Gough; Nolet).

As mentioned previously (p. 15), there are many models that attempt to visualise sustainability (Mann, 2009). Two such models used by New Zealand's Parliamentary Commissioner for the Environment use three circles to represent each component. The circles have been arranged in different ways that represent particular interests. For example, one such model is illustrated in Figure 2.1. This model is used by some people in the business sector of New Zealand, for example the New Zealand Business Council for Sustainable Development (PCE, 2002). The model has three circles, with each circle representing a component of sustainability. In this model these three components are competing interests and it is assumed that if the economy is sound,

any societal or environmental problems can be solved. There is an area of common ground in the middle, but the economy always takes precedence.

This model is referred to as weak sustainability by economists because it requires the total of capital stock to be maintained. Total capital stock refers to both man-made capital, such as buildings and machinery and natural capital, such as forests and rivers.

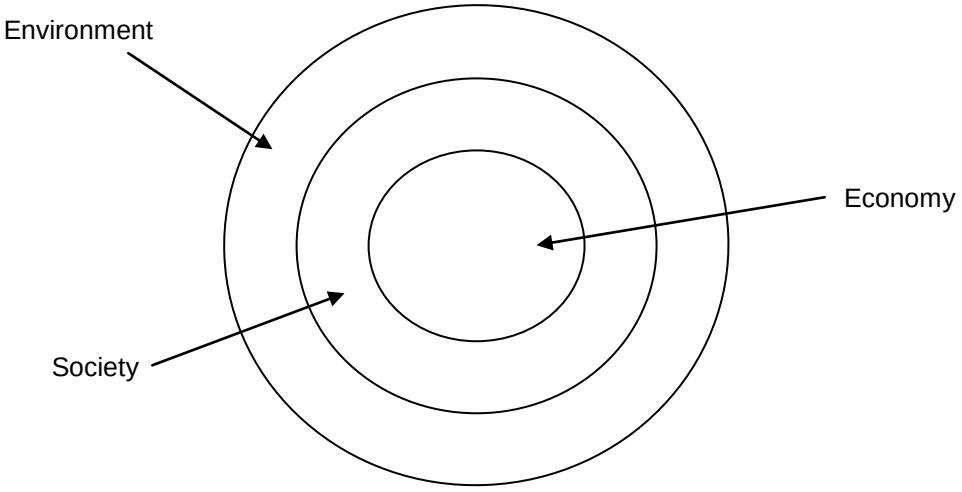


(PCE, 2002, p. 34)

Figure 2.1 Weak sustainability

Consequently if one component starts to degrade, for example the environment, its degradation can be covered by an increase in another component, such as the economy, because it is the overall total that matters. However, this model has been criticised because it is not concerned with individual components, but with the whole three and it is suggested that the components can be replaced with each other. Furthermore, this model does not acknowledge the environmental constraints in which a society and economy must operate, resulting in a "sustainable management" approach (PCE, p. 35).

Another model referred to as strong sustainability is shown in Figure 2.2 and has the circles arranged concentrically in a nested manner. This model is the one preferred by the Parliamentary Commissioner for the Environment. In this model, the economy is a subset of society, recognising that an economy only exists within society's context and that there are activities carried out in society that do not involve the economy (PCE, 2002).



(PCE, 2002, p. 35)

Figure 2.2 The ecological model of sustainability or strong sustainability

An environmental example of such an activity is volunteering to do a beach clean up or else restore a riparian strip next to a stream. Society is viewed as a sub-set of the environment because the strong sustainability model regards the environmental component as the most important. It is the most important because in order to be sustainable, societies and economic systems must operate within the carrying capacity of the Earth. In this model each component is important and cannot be substituted for the other (PCE, 2002). However, this model is open to misinterpretation because the placement of the economy at the centre suggests that the economy could be regarded as the primary component for decision-making and the environmental component having less importance.

The use of circles in both the strong and weak models presents problems. Their use suggests that the three components of sustainability are fixed in a defined structure and that there are boundaries around each component. Such a depiction also implies that one component could be privileged over the others. For example, in the strong sustainability model, the environmental component is privileged over society and the economy. Such models also encourage consideration of the components as separate from each other.

A solution to these problems is to represent the components so that there is no separation between the three since they are interconnected in a co-evolutionary and on-going relationship (Gough, 2002). In order to explain this view, the relationships between the three components will be explained within a context. Firstly, it is not possible to have a society without an economic system. Factors that can be regarded as part of our society like education or caring for our elderly, infirm or young families, can be used to justify economic behaviours, such as taxes to fund education, pensions, sickness and welfare benefits. Although such factors do not appear to directly involve sustainability, they do involve social justice or our responsibility to care for each other, which can be regarded as part of the ethic of sustainability (Fien & Tilbury, 2002).

It is the same for the economy and the environment, they too are interconnected. Many different economic activities depend in part upon the different environmental conditions, such as climate. For example the commercial cultivation of tropical fruits (economic component), such as mangoes and durian, does not take place in New Zealand because our temperate climate is not suitable (environmental component) but commercial cultivation of fruits such as apples, pears and kiwifruit is possible (economic component).

The environment can also impact on economic activities. A New Zealand example of this interconnectivity is coal mining that takes place on the West Coast of New Zealand's South Island. Some of this mining takes place on land that is dedicated conservation land such as the Pike River Mine located in the Paparoa National Park. Because of the environmental impacts to New Zealand's native flora and fauna, open cast mining of this coal seam could not take place. The coal seam (economic component) had to be accessed from under the ground and in this case, a 2.3km access tunnel had to be built through extremely hard gneiss rock to reach the coal seam (environmental component) (Bradley, 2008). In addition, the mining company had to build a

3.6km winding access road (economic component) up to the mine that avoided the ancient rimu trees found in the area (environmental component) (Carter, 2004). The company was also required to spend NZ$70,000 each year on conservation projects such as animal pest eradication during the period when the mine was in operation and reinstate the forest around the mine site after mining had finished (environmental and economic components) (Carter). Gough (2002) points out that on occasions there is conflict between environmental and economic goals but that any choices made are not absolutely one or the other, but instead different configurations of both as the Pike River Mine example illustrates.

A similar interconnected situation exists between the environment and society. For example for a city to thrive, there are three environmental elements that are considered the most important: the climate, the shape of the land and a water supply (Yeomans, 1971). The city of Auckland, which is New Zealand's largest city, can provide an illustration of how these elements interact. Auckland has a temperate climate which makes living pleasant in that there are usually no weather extremes such as intense tropical storms or frequent blizzards (environmental component). It is bounded by the Hunua Ranges in the south-east, the Bombay Hills to the south, the Waitakere Ranges to the west and Albany Hill to the north (environmental component). The hills within the Auckland region are steep enough to provide drainage of rainwater without continual flooding but are not too steep in that housing and roads can still be built on their slopes (environmental component). There is also usually sufficient water from rainfall that is stored in dams in the Hunua and Waitakere Ranges (environmental component). The interaction of these environmental elements enables people to live in Auckland (social component). In these ways, our social and economic interactions cannot be separated from our understanding of our environment and thus the three components need to remain unbound because of their on-going relationship (Gough, 2002).

Another contribution to the complexity of this interconnectedness is that the social component of sustainability includes people's cultures, an element which is often overlooked in many attempts to define sustainability (González-Gaudiano, 2006). The reason for including this cultural element is that preserving a variety of cultures and their associated traditions and languages is considered to be essential (Ahlberg, 1998) so that multiple ways of interpreting our world can be considered (González-Gaudiano). Such preservation of culture means that people who practise their cultures and speak their languages can still identify as people of a particular culture and celebrate their heritage. By maintaining a variety of cultures and languages the richness of the diversity of cultures and languages can celebrated and maintained. A New Zealand example of this cultural element is the establishment and growth of kohanga reo or language nests. The purpose of kohanga reo was to ensure the survival of the Maori language and customs (Te Kohanga Reo Trust, 2010). In 1982 when the first kohanga reo opened, use of the Maori language was in decline. Kohanga reo were set up and run by local communities using fluent speakers of Maori to teach the children and support parents in their learning as well (Aperira, 2010). Kohanga reo are still operating today and although common use of the Maori language is still infrequent, children

are emerging from the kohanga reo fluent in Maori and knowledgeable about the customs of their ancestors (Te Kohanga Reo Trust). In this way both the language and culture are being sustained.

In summary, it has been argued that sustainability is comprised of three components: the environment, society and economy. These components cannot be separated and are interconnected in a co-evolutionary and on-going relationship. For example, economic activity, such as mining affects the environment and environmental factors, such as location of a coal seam, affect economic activities. Similarly, the environment can affect where people live and people change their environment to suit them. Therefore, these interrelated components in their on-going relationship form an important part of a definition of sustainability.

Taking the challenges, issues and components into consideration, a definition of sustainability has been developed for this thesis and will now be presented.

2.4 A definition of sustainability

Given the contested and complex nature of sustainability along with the challenges and issues associated with its definition, the researcher has developed a definition of sustainability which incorporates its components and connections that will be used in this project. It states that:

> Sustainability is made up of three interrelated components: environmental, social and economic. These components interact in ways that are unpredictable and co-evolutionary that effect further environmental change with unforeseen outcomes. Sustainability is a dynamic process but not the end point when working to resolve an environmental issue.

The elements within the definition will now be discussed. The first sentence contains the idea that sustainability is comprised of three interrelated components: environmental, social and economic, as agreed upon by many environmental educators such as Corney and Reid (2007); Gough (2002); Nolet (2009); and Sterling (2010). The second sentence refers to the idea that these three components are not separate and have a co-evolutionary, on-going relationship (Gough). Each of the components affects the others, and because our knowledge is limited, we can never be certain about future outcomes. In order to cope with such uncertainty and change, people need to be flexible and open-minded, which relates to the concept of resilience (Plummer, 2010) and to the unbound nature of the three sustainability components (Gough).

The final sentence incorporates the temporal nature of sustainability. It refers to the idea that when working towards the resolution of an environmental issue, a time can be reached where sustainability seems to have been achieved, as in the example of the pohutukawa given earlier. However, we can never be certain of future outcomes because our interactions with the environment can be regarded as a socio-ecological system (Lundholm & Plummer, 2010). Uncertainty and change arise because a socio-ecological system is complex and consequently it

can change and adapt, resulting in unforeseen outcomes. For this reason, an environmental issue is on-going and sustainability does not have an end point.

This definition is represented diagrammatically in Figure 2.3 which illustrates the way that the definition developed by the researcher is comprised of three components: the environment, society and the economy. These components are shown without boundaries so that no component is privileged over the others. Their interconnectedness is represented by the double-headed arrows. The temporal component of sustainability is shown by the arrow on the left pointing upwards. On the right of the arrow are the three parts of the temporal component, the past, present and the future. The inclusion of these parts to the temporal component represents the on-going relationship between the three components, the effects of the past and the uncertainty of the future. The inclusion of the upward arrow and the future part in the temporal component relates to the concept of resilience and the way that sustainability is a dynamic process with no end point being achieved in some future time.

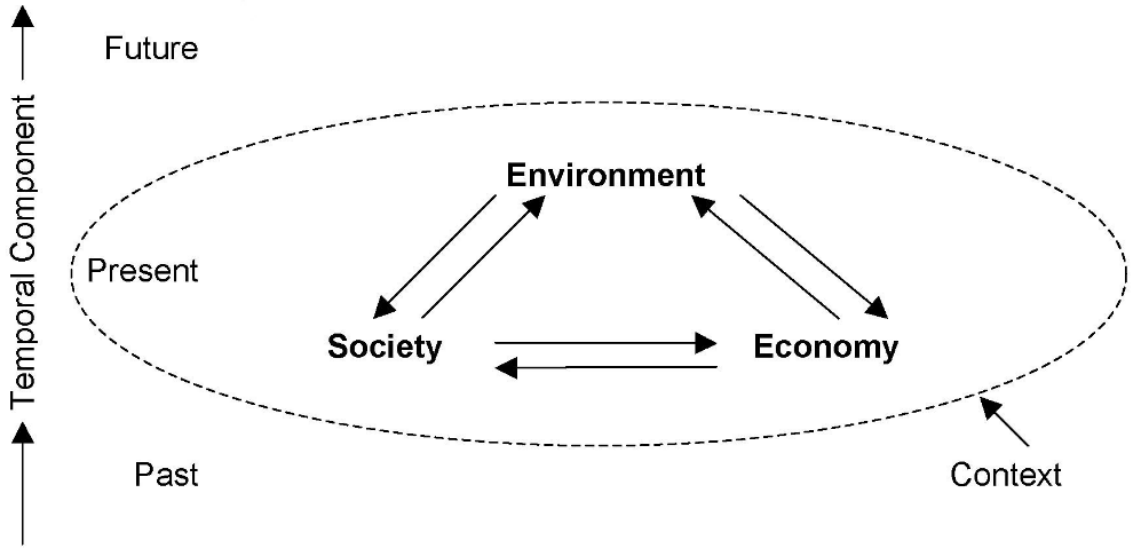


Figure 2.3 The researcher's theoretical definition of sustainability

Around the three interrelated components and encompassing the present part of the temporal component is an oval representing the way that the concept of sustainability needs to be located in a context. The oval has a dotted line to show that the components are not necessarily bound within this context. The real world is not neatly made up of a series of separate contexts, instead it is messy and contexts overlap and intersect with each other. This idea is related to one of Tilbury and Cooke's (2005) approaches used in EfS entitled *Systemic Thinking*, where properties of whole systems are studied, rather than pieces. This oval incorporates the present part because this is the point where a definition of sustainability is located at a particular time but is not the end point.

Not only is sustainability difficult to define, reading literature about sustainability can be confusing. The reason for confusion is that two different terms are used – 'sustainability' and 'sustainable development'. For example, the definition found in *Our Common Future* (WCED, 1987), referred

to sustainable development but some people regard this definition as one that applies to sustainability. On occasion, sustainable development and sustainability have been viewed as interchangeable (Nolet, 2009). More recently a distinction between these two terms has been made. Therefore, the difference between sustainability and sustainable development needs clarification and is the focus of the next section.

2.5 Sustainability and sustainable development: Is there a difference?

Although the terms 'sustainability' and 'sustainable development' were once used interchangeably, they are now used separately as they mean different things to different people (Nolet, 2009). For example, New Zealand's Parliamentary Commissioner for the Environment (2004) views sustainable development as a quest for a better quality of life for everybody and their surroundings but not at the cost of degrading the environment for future generations. Sustainability, in his view, is then seen as the destination or end point of this quest.

The term sustainable development first became prominent in 1980 when the World Conservation Strategy was launched (Fien & Tilbury, 2002) and was further popularised with the publication of the report *Our Common Future*, also known as the *Brundtland Report* (WCED, 1987). This report was seminal in that it was the first international policy document to identify the interrelationship between the environment, society and economic systems (Nolet, 2009). It also identified that our current environmental problems are the result of the colossal poverty in developing countries and the profligate consumption patterns in the developed countries (Nolet).

Since this time, there has been considerable discussion and debate around sustainable development. Like the term sustainability, it is regarded as ambiguous and fuzzy (Stevenson, 2006). Some consider it an oxymoron because the word 'development' implies continual growth, requiring increasing amounts of resources from our Earth. Continual growth is not sustainable because Earth's resources are finite and if people keep using them, eventually there will be no more left. Thus sustainable development is not possible (Nolet, 2009; Selby, 2006).

Others engaged in this discourse claim that sustainable development has become the means to maintain the current economic status quo (Stevenson, 2006). Both Irwin (2007) and Selby (2006) go even further, arguing from a critical perspective that sustainable development has been captured by the economists and it is their language, values and beliefs that are being enacted under the slogan of sustainable development. They argue that the majority of economists perceive sustainable development in a managerial and technicist way meaning that growth continues by using resources less intensively and relying on new technologies such as genetic modification to find substitutes for resources (Selby). By enacting sustainable development in this way, economists are ensuring that the rate of economic growth continues along with our modern culture of consumerism but are disregarding the evidence of its effects on people and our biosphere, such as deforestation, global warming and extinctions (Irwin).

In addition, this view of sustainable development is an instrumental view of our environment, underpinned by the assumption that nature is there to supply the needs of people and also to contain our waste. Selby (2006) argues that viewing nature in this way is evident in the way that the *Brundtland Report* (WCED, 1987) does not acknowledge other species, either plant or animal, who also occupy our planet and this worldview with 'other-than-human' in an inferior position reveals people's egocentric beliefs and values.

Such an instrumental view of nature is also illustrated by Irwin's assertion that sustainable development has become embedded in the market (2007). Here Irwin is referring to the way that everything, from events, practices and even knowledge have become a 'consumable resource' available on the free market for people to access. The current neoliberalist view sees the market as a mechanism for balancing the costs and benefits of people's desires and needs. It is seen as the best system for the distribution of resources as it is both apolitical and unbiased with the government only regulating the market when absolutely necessary. In this way the market has moved beyond being a mechanism to a metaphor for the way that people interact with their environment because the market is seen as being able to distribute resources far more fairly than any political system. As a metaphor, the market is all-pervading in our lives and as Irwin argues, has become a 'hidden metaphysical law'. Thus, instead of sustainable development principles guiding the market, the market determines what is sustained (Irwin).

Finally, it is argued by Sauvé, a Canadian environmental educator that sustainable development is a cultural issue because the concept of 'development' is, in effect, a Western idea (1999). Other cultures, such as Maori, Amerindian or African, are not totally focused on making the future more plentiful. Instead these cultures acknowledge their past and they focus on the present, ensuring a balance and a unity of all living things. Therefore, Sauvé asserts that sustainable development is not easily recognisable for many of the world's cultures and consequently difficult to implement. An example of New Zealand Maori working to ensure a balance through restoration, was their support given to the proposed creation of a marine reserve at Mimiwhangata on the east coast of New Zealand's North Island (Kerr & Grace, 2004). Houpeke Piripi, Kaumatua (elder) of Ngatiwai Iwi and the hapu of Te Uri O Hikihiki (the local Maori iwi), called for a rahui tapu or a total ban on fishing in this area because of the dramatic decline in fish populations. Piripi wanted this rahui tapu to last for 20 to 25 years so that the ecology of the area could be restored (Kerr & Grace). In this way the Maori concept of rahui tapu runs counter to sustainable development because the creation of a marine reserve and implementation of rahui tapu would mean no continued development of Mimiwhangata. Instead Mimiwhangata would have to remain untouched.

While the concept of sustainability has been equally criticised, it is usually seen as having a greater focus on encouraging social equity and maintaining environmental quality, rather than promoting economic growth (Sauvé, 2005). Some people, particularly those from developed countries like New Zealand, Australia and the United Kingdom, prefer to use the term sustainability rather than sustainable development because of their objections to the word

'development', as discussed above (Tilbury & Cooke, 2005). For these reasons, this research project will use the term sustainability.

2.6 Chapter summary

This chapter has discussed the importance of people being able to develop an understanding of sustainability that they can use in their everyday lives in the hope that such understanding could affect their pro-environmental behaviours. The challenges associated with defining this complex concept have been identified: its evolution; its ambiguity and value-laden nature; its abstraction and need for contextualisation; and the necessity for an environmental issue to be placed in a temporal scale. The issue of incorporating resilience and its contribution to a definition of sustainability has also been discussed. The three components of sustainability, the environment, society and the economy have been presented and their interrelationships discussed.

Based on these discussions, a definition of sustainability has been created for use in this project. This definition has also been presented diagrammatically. The chapter concluded with a discussion that distinguished between the two terms 'sustainability' and 'sustainable development' with sustainability being the term used in this project.

Given the importance of people developing an understanding of sustainability, this research project aimed to find out what student and practising teachers thought that sustainability meant. Therefore the following research question will be investigated:

- What are student and practising teachers' understandings of the concept of sustainability?

Chapter 3: Incorporating Sustainability into Education: Implications for Pedagogy and Teacher Identity

3.1 Introduction

As argued in Chapter 2, developing an understanding of sustainability is important to effect change in people's awareness of environmental issues so that they could feel motivated to make changes in their everyday lives to halt environmental degradation (Jucker, 2002; UNESCO, 2005). However, developing an understanding of this concept is difficult because of its complex and contested nature (Corney & Reid, 2007). Education is viewed as a key strategy to assist people to develop their understanding of sustainability (UNESCO, 2005).

Since education is seen as having this role, this thesis argues that teachers need to develop their understanding of this concept in order to teach about sustainability (Shulman, 1986). Their understandings then need to be translated into their pedagogy, or what is known as their pedagogical content knowledge (PCK). In order for both development of understandings and translation into pedagogy to occur, teachers need professional development (Marcinkowski, 2010). However, while teachers report enjoying participation in professional development, there is not a lot of evidence to show that this development results in the desired changes in teachers' pedagogy or in children's understandings (Timperley, Wilson, Barrar & Fung, 2007).

This research project suggests that when researching teachers' pedagogy, it is also important to consider their professional identity because teachers' experiences and images of themselves strongly influence their pedagogy (Cohen, 2010). Furthermore, it is based on the premise that identity is related to one's learning, and as a person learns they develop a sense of who they want to become. Such a vision then inspires each person to work towards that goal (Brickhouse, 2001). Therefore, it is proposed that as teachers develop an understanding of sustainability and translate it into their pedagogy, these actions could also affect their identities as teachers of EfS programmes.

3.1.1 Chapter structure

The visibility of education for sustainability in New Zealand's curriculum documents is discussed in Section 3.2. Section 3.3 contains a discussion about the purpose and practice of education in relation to EfS programmes and the complexity of teaching about sustainability is explored in Section 3.4. Research into teachers' understandings of sustainability is then analysed for opportunities for further research in Section 3.5. Issues around professional development for teachers are discussed in Section 3.6 and the elements of pedagogical content knowledge outlined in Section 3.7. In Section 3.8 a learning theory with the potential to explain how people develop understandings about sustainability is presented. The final section, Section 3.9, discusses the concept of teacher professional identity.

3.2 The visibility of sustainability in New Zealand's curriculum documents

Despite New Zealand being a signatory to *Agenda 21*, education for sustainability (EfS) continues to occupy an ambiguous and marginalised position in New Zealand's schools. This marginalisation makes it difficult for teachers to implement EfS into their classroom programmes. This difficulty is evidenced by the small number of New Zealand schools known to be teaching EfS programmes. For instance, in 2008, 419 schools were involved with the Enviroschools Programme with around 100 other schools having had contact with EfS professional support providers - a total of around 25% of New Zealand schools (Eames, Roberts, Cooper & Hipkins, 2010). There appears to be three reasons for this position: EfS's status as a new learning area; its lack of a governmental mandate, and issues with *Guidelines for Environmental Education in New Zealand Schools* (Ministry of Education [MoE], 1999), the EfS specific curriculum document and supporting material.

Firstly, EfS is a relative newcomer to New Zealand's education system. Initially it seemed that EfS would have a place as one of the essential learning areas when a review of the curriculum was begun in the early 1990s. This initial promise was not realised and instead *The New Zealand Curriculum Framework* (MoE, 1993) contained only signals pointing to learning about environmental and sustainability issues in many of the seven learning areas, but particularly in science, social studies and technology. At this time no overt direction for the teaching of EfS was given and teachers and schools wanting to implement EfS had to use 'indicators', or words that implied sustainability, from the existing learning areas (Eames, Cowie & Bolstad, 2008).

A further curriculum review process began in 2000. This review took the form of a curriculum stocktake project undertaken by the Ministry of Education with the goal of reviewing and analysing current issues and future directions for the New Zealand curriculum. One issue was the request for further learning areas, such as EfS. Following an analysis of these requests and a recognition of government priorities, together with the perceived current and future needs of society, 'future-focused themes' were developed. These themes included ideas such as citizenship; bicultural and multicultural awareness; enterprise and innovation and education for a sustainable future. The report suggested *emphasising* these themes within the curriculum instead of increasing the number of learning areas (Bolstad, Eames & Robertson, 2008) and consequently, when *The New Zealand Curriculum* (MoE, 2007) was published, it too did not contain EfS as a new learning area.

Education for sustainability's continued lack of presence in New Zealand curriculum documents means that EfS has no clear mandate for its teaching and learning. With no mandate, New Zealand schools do not have to teach EfS and it remains optional. The reason given for not making EfS a compulsory learning area was that the curriculum was already perceived as being 'overcrowded' (Bolstad et al., 2008). Indeed, it appears that some teachers view EfS as an 'add-on' that competes for their attention with other governmental initiatives, such as numeracy and literacy, while others regard EfS as competing with national assessment programmes at secondary school level (Bolstad, Cowie & Eames, 2004). Chapman (2004), arguing from a radical perspective, states that the lack of a mandate for EfS is an avoidance strategy. With no

mandate, changes to education do not have to occur and Chapman regards this strategy as calculated and disparaging.

This lack of a discrete learning area for the teaching and learning of EfS is reflected in many other countries around the world besides New Zealand (Gough, 1997). In fact the issue of whether EfS should be a learning area that stands alone like science or technology, or if it should be infused across the whole curriculum, has been debated worldwide (Barker, 2001). Because New Zealand had no EfS curriculum in the early 1990s, the infusion model appears to have been adopted by default (Eames et al., 2008). New Zealand's response is in direct contrast to England and Wales where EfS or education for sustainable development as it is called there, is a new learning area in their National Curriculum (Summers & Kruger, 2003). After a slow start, education for sustainable development is now firmly established in England and Wales and is moving up the curriculum development agenda at a fast pace with a report produced on good EfS practice, a draft national strategy published and a briefing paper commissioned by the Teacher Training Agency (Summers, Childs & Corney, 2005).

Even though in New Zealand EfS is not mandated, the Ministry of Education has published non-compulsory *Guidelines for Environmental Education in New Zealand Schools* (MoE, 1999), referred to from here on as the *Guidelines*. This document's role is to provide support for New Zealand schools to implement EfS. However, because EfS is not mandated, the publication of the *Guidelines* sends a mixed message to teachers, that is on the one hand providing support but on the other not mandating its implementation (Eames et al. 2008). In 2007 the process of revising the *Guidelines* was begun and discussion centred around defining EfS, its intent and deciding on the content of the revised document (Chapman & Eames, 2007). There was also discussion around the purpose of education in society and the need for a public able to engage with environmental issues in detail besides what a revised EfS curriculum should contain (Chapman & Eames). Unfortunately, due to a change in government, this consultation process stopped (p. 2). A further related issue is the lack of support material available from the Ministry of Education with which to teach EfS (Eames et al., 2010).

Given that EfS is not a discrete learning area, its non-mandated status and issues around curriculum and supporting materials, its visibility is not high and as a result, teachers and schools do not find EfS easy to implement. However, the latest revision of the New Zealand curriculum is a departure from previous documents in that it encourages schools to interpret learning for students in their particular context (Chapman & Eames, 2007). In this way, the curriculum is less prescriptive and teachers have the authority to decide on relevant learning contexts for their students. This freedom means that schools who want to plan and teach EfS programmes are able to do so. Even though EfS is not a discrete learning area, there are signals in the latest revision of the curriculum that provide spaces for the teaching and learning of EfS to take place (Bolstad et al., 2008).

For example, in *The New Zealand Curriculum* (MoE, 2007) there is reference to a vision of what educational endpoints are wanted for young people and this includes being able to take advantage of opportunities offered by "new knowledge and technologies to secure a sustainable social, cultural, economic, and environmental future for our country" (MoE, p. 8). In the Principles given to guide curriculum decision-making (MoE, p. 9), reference can be found to the underlying philosophy of EfS such as reflecting cultural diversity, inclusivity, community engagement as well as the future-focused themes of sustainability and citizenship. Reference to the underlying philosophy of EfS can also be found in the Values section that encourages exploring and modelling the values of diversity, equity, community and participation for the common good, along with ecological sustainability (MoE, p. 10). Five Key Competencies which enable young people to live, learn, work and contribute as active members of society are listed in *The New Zealand Curriculum* (MoE, pp. 12-13). Fostering these competencies, such as thinking and relating to others, also form part of the specific pedagogy associated with EfS. Finally, while all of the eight mandated learning areas could be integrated into an EfS programme, specific references to sustainability and the environment can be found in the following areas:

- *Health and Physical Education*, for example "… they [students] are increasingly able to take responsibility for themselves and contribute to the well-being of those around them, of their communities, of their environments (including natural environments), and of the wider society." (MoE, 2007, p. 22)

- *Science*, for example "By studying science, students use scientific knowledge and skills to make informed decisions about the communication, application, and implications of science as these relate to their own lives and cultures and to the sustainability of the environment." (MoE, 2007, p. 28)

- *Social Sciences*, for example "Through the social sciences, students develop the knowledge and skills to enable them to: better understand, participate in, and contribute to the local, national, and global communities in which they live and work; engage critically with societal issues; and evaluate the sustainability of alternative social, economic, political and environmental practices." (MoE, 2007, p. 30)

- *Technology*, for example "They [students] learn to critique the impact of technology on societies and the environment … as they do so, they come to appreciate the socially embedded nature of technology and become increasingly able to engage with current and historical scenarios and to explore future scenarios." (MoE, 2007, p. 32)

In summary, even though EfS and references to sustainability can be found in the latest revision of New Zealand's curriculum, its inclusion is not obvious and teachers either need to search for references or else access professional development to assist them in the planning of EfS. To further add to the challenges of implementing EfS, there are issues with its teaching. These issues will be discussed in the next section.

3.3 The purpose and practice of education in relation to education for sustainability

While it can be demanding for teachers to find signals in *The New Zealand Curriculum* (MoE, 2007) for the planning of EfS, there are also challenges with its teaching and learning. These challenges include the way that EfS has changed its focus, evolving from environmental education (Tilbury, 1995); the wide range of skills and degree of knowledge required for its teaching (Kysilka, 1998; Hart, 2010), and finally the discrepancy between EfS policy and how EfS is enacted in classrooms (Chapman & Eames, 2007; Stevenson, 2007a, b). Each challenge will now be discussed.

The first challenge arises because EfS, like the concept of sustainability, has evolved over time. Prior to the 1970s, EfS, or environmental education as it was then known, was not a concept in its own right (Tilbury, 1995). It emerged in Britain in the 1970s from four related, but distinctive, movements: environmental studies; outdoor education; conservation studies, and urban studies. By the 1980s environmental education was recognised as an area of study with its own philosophy (Tilbury). Then in the 1990s, environmental education evolved into EfS. This evolution came about mostly because it was realised that environmental education tended to only involve nature studies at primary level and ecology at the secondary level, and that this type of knowledge did not appear to be bringing about changes to people's lifestyles that would have less impact on our biosphere (Fien & Tilbury, 2002; Tilbury).

As a result of the Earth Summit in 1992, UNESCO called for a reorientation of education towards sustainability in recognition of the fact that our environmental problems are anchored in our history as well as in our social, cultural, political and economic systems, and that in order to effect change, young people needed to learn about these systems (Tilbury, 1995). This change represents a shift in focus from just the environment, to the inclusion of social and economic concerns (Stevenson, 2006). The reorientation resulted in a renaming of environmental education to education for sustainability. Along with the inclusion of the concept of sustainability, EfS is a far broader area of learning than its predecessor, environmental education. In fact EfS is viewed as holistic and multidisciplinary in nature, requiring learners to use knowledge and skills from all learning areas across the curriculum. It also needs to be set in a context of an environmental issue that is relevant to the young people's world. In addition, EfS is perceived as an area where young people learn about links between the quality of our environment, human rights and social justice. Lastly, EfS includes components such as values clarification, learning a variety of action skills and developing political literacy so that people can become 'agents of environmental protection and change' (Fien & Tilbury, 2002; Nolet, 2009; Tilbury).

EfS, therefore, is a broad ranging learning area, requiring a high degree of knowledge and skills from teachers. This is a challenge, for example, being able to teach in an interdisciplinary manner requires a wide-ranging comprehensive subject-matter knowledge if teachers are to blend subject areas such as science and economics successfully (Kysilka, 1998). Not only do teachers need comprehensive subject-matter knowledge, they also need to know how political systems work to

provide information about the background to complex political decisions. Such knowledge might then prepare their students to actively participate in local, national and global issues (Hart, 2010). However, another challenge further complicates EfS teaching and learning. This challenge relates to the current purpose and practice of education which some EfS educators believe runs counter to the goals of EfS and will now be explored.

This challenge of EfS's goals contradicting the current purpose and practice of education is not limited to just New Zealand. North American environmental educators such as Jickling and Wals (2008), Stevenson (2007a) and Hart (2010) argue that our current schooling system with its roots in the nineteenth century, serves to maintain the existing conditions and relations in society. In other words, education is a form of social reproduction where its goal for learners is to gain basic skills in literacy and numeracy and learn basic information. They argue further that it is the dominant cultural practices that are transmitted to students, influencing credentialing systems and having a significant influence on students' future economic well-being and life chances. Consequently, many governments now see education's purpose as production of a workforce (Jickling & Wals; Stevenson, 2007b).

New Zealand's recently revised curriculum document, *The New Zealand Curriculum*, can be interpreted as having this goal (Chapman & Eames, 2007). For example, this curriculum has the future-focused themes of enterprise and globalisation, which could be interpreted as an emphasis on producing a workforce. Further evidence from this document shows that while promoting the ideal of developing life-long learners, see for example p. 8 and p. 37 (MoE, 2007), the purpose given for developing such skills is so young people should be able to "… meet the changing needs of the workplace and the economy." (MoE, p. 42).

Stevenson (2007b), critiquing the United States' education system, further argues that in order to maintain the status quo and produce workers, a particular type of curriculum and pedagogy have been adopted by schools in the United States. Firstly, the curriculum and its content are prescribed with a narrow focus, particularly in the primary years, on literacy and numeracy because these learning areas are seen as important for workers employed in the global economy. Other learning areas, such as art, dance, health and social sciences, do not receive as much emphasis and are often squashed into smaller amounts of time in the school day. There is an emphasis on assessment, and particularly standards-based assessment. Because this type of assessment is viewed as high stakes, teachers tend to focus on basic skills, employing a transmissive teaching style that sees them as the 'dispenser' of knowledge to ensure coverage of required material. This teaching style can result in learners being passive and not needing to utilise higher order thinking skills (Stevenson, 2007a). As a consequence of this high stakes assessment that affects individual life chances, knowledge is seen as a commodity that individuals need to attain. In this way, Jickling and Wals (2008) and Stevenson think that learning has become atomistic and closed, focused on the individual, competitive, determined by governments or special interest groups like industry and tightly prescribed so that learners receive the 'right' information, values or beliefs.

In direct contrast, Jickling and Wals (2008) and Stevenson (2007a, b) assert that EfS challenges this dominant educational system, seeking to undermine currently accepted capitalist beliefs and values to bring about change. They propose that EfS programmes do not have predetermined outcomes and content but are more emergent and viewed as socially transformative in nature. Ideally, EfS programmes are holistic, multidisciplinary and encourage learners to work co-operatively, envisaging possible futures and thinking critically about their world. As EfS programmes usually focus on local environmental issues, the learning is considered to be open, more personally relevant to learners and often more motivating. Unlike the earlier described form of schooling, knowledge is not dispensed by the teacher, but is often co-constructed alongside the learners. Thus Stevensen (2007a) argues that when EfS is taught in this recommended manner, learners are more active and are generators of knowledge, rather than recipients. Knowledge is not seen as a commodity for individual gain, but a way of developing intellectually and, when used to solve problems, is a way of bringing about social change. Consequently, Jickling and Wals assert that EfS programmes aim to foster citizenship by educating learners to develop their own opinions, to be critically aware of their world and able to take part in decision-making processes at both a local and global level to bring about changes towards a more sustainable way of life for all.

This critique comes from a North American perspective and while New Zealand environmental educators Chapman and Eames (2007) do acknowledge that schools have a social reproduction role and reflect society, they also suggest that there is potential within New Zealand's recently revised curriculum for the teaching of EfS. They argue that this potential can be seen in two foci, the emphasised relationship between the curriculum and what is enacted in classrooms and the key competencies. This revised curriculum is less prescriptive than past curricula documents and schools are encouraged to design a curriculum "in response to the identified interests and learning needs of their students." (MoE, 2007, p. 44). In this way it can be regarded as a "framework" (MoE, p. 37) rather than a specified plan for teaching and learning. This flexibility means that schools are able to choose to study environmental issues in their programme, provided that they align the learning with the appropriate achievement objectives.

The New Zealand Curriculum (MoE, 2007) also introduced key competencies to New Zealand schools. According to Chapman and Eames (2007), the teaching of these key competencies also has potential for the teaching of EfS in a way described by Jickling and Wals (2008) and Stevenson (2007a, b). The competencies are: thinking; using language, symbols, and texts; managing self; relating to others; and participating and contributing. They are referred to as "capabilities" (MoE, p. 38), to be used and developed across all learning areas so that students can become life-long learners and active members of their community.

Each of these key competencies can be related to elements of an EfS programme as described by Jickling and Wals (2008) and Stevenson (2007a, b). For example, the thinking key competency promotes "creative, critical and metacognitive processes" (MoE, 2007, p. 12), types of higher order thinking that could result in the generation of knowledge. The using language, symbols, and texts key competency promotes "making meaning of the codes in which knowledge

is expressed" and being able to "recognise how choices of language, symbol or text affect people's understanding" (MoE, p. 12) and could assist with the gathering and evaluation of information associated with an environmental issue or else the critique of a media report about an environmental issue. Both of these key competencies could help students to form their own opinions, question underlying power structures and become more critically aware of their world.

Relating to others which is about "interacting effectively with a diverse range of people in a variety of contexts" (MoE, 2007, p. 12) could provide a focus to help students to work together co-operatively, co-constructing knowledge and discussing possible solutions to environmental issues. The managing self key competency is about "seeing themselves as capable learners" (MoE, p. 12) and could provide space to help students to become self-directed in their learning and as a consequence, the learning outcomes and content then become emergent.

The last key competency, participating and contributing, is about "being actively involved in communities" (MoE, 2007, p. 13) and relates directly to the taking of action in EfS programmes. This key competency could enable students to make decisions about actions, implement them and then evaluate their actions.

However, *The New Zealand Curriculum* (MoE, 2007) only offers an invitation to the teaching of EfS programmes. As discussed previously (p. 30), it is not mandated. Since there is no prescribed curriculum, it is up to individual schools and teachers to take up the invitation and plan for "intentional teaching" (Epstein, 2007, p. 1). Intentional teaching refers to the way that a teacher acts with specific goals and knowledge to make certain that children develop the understandings and skills intended. Epstein asserts that this type of teaching requires teachers to use their pedagogical content knowledge to plan and teach relevant learning experiences related to the intended goal, which in this project is the teaching of EfS. Therefore, there is an opportunity to find out if New Zealand teachers have taken up this invitation and intentionally planned for EfS learning as well as finding out if the potential of the key competencies is realised in an EfS programme.

It must be noted, however, that despite the perceived value of implementing EfS in the manner described, it does have its critics. The complexity of teaching EfS will be discussed in the next section.

3.4 The complexity of teaching education for sustainability programmes

While the nature, purpose and practice of EfS appears to be of more value to the future of our planet than the current education paradigm, EfS does have its critics. Criticisms centre around the name of this type of learning, its ideological basis and pedagogical realisation as well as the lack of a clear framework for bringing about change in learners' behaviours.

Firstly EfS is known by many different names, for example education for sustainable development, education for a sustainable future or sustainability education (Stevenson, 2007b). This range of names reflects the wide variety of philosophies underpinning the teaching and

learning about ways of changing to live in a more sustainable manner. The variety of names illustrates the complexity of EfS and the potential difficulty for educators and researchers to communicate ideas when discussing their work. For example, Sauvé, a Canadian environmental educator, has developed a typology of what she refers to as "currents of intervention" (Sauvé, 2005, p. 11), where 15 different types of environmental education/EfS of various names are mapped. These currents range from a "naturalistic current" (Sauvé, p. 13) where the intrinsic value of nature is recognised and people learn through immersion in groups with a culture that have a close relationship to natural settings. At the opposite end lies the "sustainable development/sustainability current" (Sauvé, p. 29) where the goal is to change societies' economic structures and transform both production and consumption patterns.

This naming continues with Selby (2006) arguing that there is something 'anti-educational' about calling education 'for' something even before learning has started. Jickling and Wals (2008) maintain that the reason for it being considered anti-educational is that the word 'for' implies that there are prescribed outcomes and a set agenda rather than the flexibility of open learning and space for individuals to develop their own ideas. Jickling and Spork (1998), in synergy with Jickling and Wals, argue that the idea of having a set agenda suggests a training programme, which is an instrumental approach, or could even be regarded as indoctrination, which again is contrary to the stated purposes of EfS. This idea of indoctrination is advanced by Sauvé (1999) who claims that by calling such education 'education for sustainability', educators are placing sustainability at the pinnacle, making it the supreme value under which all other values, such as social responsibility must unite. By elevating sustainability in this way to be the privileged doctrine, it then becomes the foundation of this educational paradigm creating a predetermined choice, which again runs counter to the purposes of EfS (Jickling & Wals; Sauvé).

According to Selby (2006), EfS has also been referred to as a 'seductive mantra' because, like the concept of sustainability and as discussed above, it can mean all things to all people. In this way distinctions in meaning are blurred and contradictions flattened out. As a result, Selby argues that the potential for learning from critical thinking and thoughtful debate about the environment is lost. Jickling and Wals (2008) go even further, asserting that in effect, EfS can become a diversion rather than a means for working towards solutions to our environmental issues.

In response to these arguments, Jickling and Wals (2008) argue that having a lack of consensus around what EfS, sustainability and sustainable development education entail could be a good thing. Forcing people to arrive at a consensus could take away EfS's democratic dimension. Such a wide dimension is needed in education to enable individuals to develop a sense of self and of others, as well as a sense of community. If people have no space to develop their own ideas, Jickling and Wals argue there would be no opportunities for debate or the creation of dissonance in individuals' currently held worldviews and, therefore, no opportunities for change to occur in our societies. As a result, Sauvé (1999) asserts that EfS then serves to maintain the values and practices of modernity instead of providing opportunities to bring about change.

While Jickling and Wals (2008) and Sauvé's (1999) criticisms might appear to weaken the argument for this researcher's definition of sustainability (p. 24), this definition was not intended to be learnt and used definitively. Instead the researcher intended it as a guide for people to use to interpret instances of sustainability in their everyday lives and as a research analysis framework. In this way, because people have different experiences, the researcher envisaged that people would hold slightly different ideas from each other about this complex concept.

The above criticisms are directed at the ideological basis of EfS programmes. EfS also has a particular pedagogy as described in the previous section (p. 35). While the pedagogy associated with EfS has not attracted nearly as much criticism, it has been pointed out that the pedagogical realisation of EfS is not actually new. Sauvé (1999), for instance, argues that its characteristics are still the same as those promoted as environmental education twenty years ago. She claims that these characteristics are, in fact, nothing particularly different as they are part of the progressive education movement, for example the inclusion of the characteristic of critical reflection, which originated with John Dewey (1997).

Finally, the third challenge relates to teachers having a clear framework for the teaching of EfS programmes. In the face of the ideological and pedagogical criticisms mentioned above, it seems very difficult for teachers to develop an understanding of how to implement EfS programmes that will empower their learners to effect change. In its existing form, Sterling (2010) argues that EfS does not appear to provide a clear framework for the type of transformative teaching and learning that will bring about the change promulgated by UNESCO. However, he proposes a way through this dilemma through the development of a "transformative educational paradigm" (Sterling, p. 512) that seems to bring together many of the elements of both EfS and environmental education, as well as the development of personal resilience and an emphasis on participatory learning. This paradigm could then provide a framework for learning.

Sterling (2010), arguing from a United Kingdom context, proposes that there are actually two different types of EfS – instrumental and intrinsic – and that both are needed. Instrumental EfS is seen as behaviourist and prescriptive, a 'remedial vehicle' that will enable learners to change their behaviours to those that will bring about a more sustainable lifestyle. This type of EfS assumes that learning is linear in nature and by developing content knowledge and raising awareness, learners will be able to effect social change.

On the other hand, the intrinsic type of EfS views the focus on changes to behaviours that are sustainable or protect the environment as secondary. Instead the development of learners' ability to make appropriate choices for a future, that is both uncertain and complex, is seen as paramount. Consequently, intrinsic EfS involves developing learners who are critically reflective, can think systemically and can make informed decisions. Knowledge is believed to be socially constructed and, unlike instrumental EfS, sustainability and environmental issues are seen as contexts in which to develop such knowledge rather than the determinants of that knowledge (Sterling, 2010).

According to Sterling's (2010) framework for bringing about change, more than just these two types of EfS are needed. He argues that learners also need to be resilient to be able to cope in situations of uncertainty, ambiguity and change. Resilience is a personal quality that involves reflection, being adaptable and being able to work with others. Sterling asserts that it is this quality of resilience that will help learners work towards bringing about change.

The final feature of Sterling's transformative educational paradigm (2010) is the notion that learning is participatory, which he argues is more like the type of learning that occurs in adult learning, than that usually found in formal education. This type of learning is needed because the more commonly used transmissive style is insufficient in times of uncertainty or ambiguity. Its unsuitability relates to the previous discussion (p. 34) about the purpose and practice of the current education system. As discussed before (p. 34), the current system emphasises individuality and prescribed outcomes. Under the current system, the curriculum and valued knowledge are determined by governments and/or special interest groups. Sterling's proposed framework encourages the teacher and learners to work together, co-constructing knowledge that is relevant to the real-life issue being studied so that the learning emerges from the issue.

However, as argued by Sauvé (1999), this type of pedagogical approach is not specific to EfS. She claims that many people often confuse the types of pedagogical approaches espoused when teaching EfS with its specific nature. Instead, she points out that these pedagogical approaches are not new, but part of the progressive education movement that was instigated by Dewey (1997).

Therefore, it is the combination of these four features, the instrumental and intrinsic EfS, the development of resilient learners and learning in a participatory manner that constitute Sterling's transformative educational paradigm (2010). Teaching and learning in this way could provide a framework for educators to assist their learners to work towards making changes for the sustainability of our planet.

Given the difficulties of developing an understanding of sustainability, its lack of visibility in New Zealand's curriculum documents, together with the challenges and complexity of teaching EfS, research studies that investigated teachers' understandings of sustainability will now be reviewed. They will be reviewed in order to provide information about baseline knowledge of this concept and its implementation in classrooms. Scope for further research will also be identified.

3.5 Research about teachers' understandings of sustainability

While there appear to be no New Zealand studies into teachers' understandings of sustainability, there has been a recent New Zealand study into teachers' perceptions of their level of understanding about components of sustainability. In this study the teachers were not asked to articulate a definition or give examples, but instead had to identify if two professional development programmes had helped to improve their understanding of sustainability components. Eames et al. (2010) found that 85% of teachers participating in the Enviroschools programme strongly

agreed/agreed that the professional development programme had helped them to better understand environmental components of sustainability, 79% felt they had a better understanding of socio-cultural aspects and 77% said they had a better understanding of economic aspects. 63% reported a better understanding of the interdependence between these three components of sustainability. Similar figures were reported by teachers participating in the other professional development programme, National EfS Team (hereinafter referred to as NEfS) with 86% of primary teachers reporting a better understanding of environmental aspects, 81% reported a better understanding of socio-cultural aspects, 75% had a better understanding of economic aspects and 75% a better understanding of the interdependence (Eames et al.). However, caution must be used when interpreting this data because it is self-reported and has not been triangulated using observations or document analysis. These findings suggest that there is scope for carrying out research into New Zealand teachers' understandings of sustainability, by asking them to articulate a definition, to give examples and then triangulate the data thoroughly, for example through a detailed analysis of their pedagogy.

There is some international research into teachers' understandings of sustainability. For example, in Greece, 118 primary teachers were asked to define sustainability (Spiropoulou, Antonakaki, Kontaxaki & Bouras, 2007). The results were analysed using the three components of sustainability and this research showed that although almost half had some idea of the term, their understanding was superficial. For example, 42.3% did refer to sustainability being about managing natural resources correctly so that future generations had enough, but there was no reference to the economic component of sustainability. Over one-fifth (20.2%) either gave no answer or else their answer was unable to be classified. Because this research was carried out in Greece, there is scope for investigating whether New Zealand primary teachers hold similar views.

In England, Summers and Kruger (2003) conducted professional development for primary teachers based on an interpretation of sustainable development. In this study there was no analysis of the teachers' expressed understandings of sustainable development in terms of the three components of sustainability. Instead the researchers provided the teachers with an interpretation of sustainability that included concepts such as interdependence, citizenship/stewardship, diversity as well as quality of life, equity and justice. The researchers justified their action by arguing that the teachers needed specific concepts to work with to overcome the abstract nature of sustainability and to be able to attach meaning to it. This research provides further evidence that there could be a gap for research where New Zealand teachers' definitions of sustainability are compared with the interpretations of sustainability used by Summers and Kruger's teachers. Also, it could be fruitful to explore if New Zealand teachers also needed specific concepts to teach about sustainability.

In Spain, Portugal and Latin America (Argentina, Brazil, Chile, Cuba, Mexico and Panama), Gil-Perez, Vilches, Edwards, Praia, Marques & Oliveira (2003) surveyed 327 pre-service and practising teachers engaged in science education courses to find out their perceptions about the

state of the world. Using an open-ended question, Gil-Perez et al. asked these teachers to list the problems and challenges that humanity faces. Of the 57 pre-service teachers who had participated in a workshop to develop their understanding about the world's problems, 63.2% referred to sustainable development as a problem/challenge. Only 4.1% of teachers in their control group who had not participated in the workshop about the world's problems made specific reference to sustainable development as a challenge. However, this study did not ask teachers to offer a definition of sustainability. Yet again, this research indicates that there is potential for research to find out New Zealand teachers' level of understandings of sustainability.

Three United Kingdom studies have investigated graduate secondary pre-service science teachers (Summers & Childs, 2007), and graduate secondary pre-service science and geography teachers and their mentor-practising teachers' understandings of sustainability (Summers, Childs & Corney, 2004, 2005). In all of these studies, the responses were analysed in terms of the three components of sustainability represented in the weak sustainability model explained on p. 21. In each study it was found that the environmental component was the one most identified, followed by the economic and then the social component. Furthermore, identification of the interrelationship of the three components was the most difficult for these teachers. However, this study did not evaluate these pre-service and practising teachers' understandings of sustainable development before and following a series of workshops designed to deepen their understandings. These studies only investigated their existing understandings. In addition, these studies were carried out with pre-service and practising secondary science and geography teachers. Consequently, it appears that there is scope for investigating generalist primary teachers' understandings of sustainability both before and following a series of workshops.

Given that there is only one New Zealand research study into teachers' self-perceived improvements in their understandings of sustainability, as well as the small amount of international research into primary teachers' understandings, there appears to be scope for carrying out research into New Zealand primary teachers' understandings. Also, while some of the international research analysed the teachers' use of the three components of sustainability, none of these studies tracked the teachers' development of understanding following professional development.

Additionally, this researcher has developed a definition of sustainability that she planned to use in a series of professional development workshops. There does not seem to be any research where a definition has been developed for teachers, used in professional development and then the effects of using that definition on teachers' understandings investigated. This lack of research indicates a space for exploration. Therefore, the following research question will be investigated:

- How can student and practising teachers' understandings of sustainability be developed?

Since this thesis has developed a definition of sustainability for use in professional development workshops, issues around professional development will now be discussed.

3.6 Issues in professional development for teachers

In a review of the direction in which the EfS field should be moving, Marcinkowski (2010), an environmental educator from the United States, regarded professionalising the EfS community as its top challenge and opportunity. He argues that the EfS field needs not only EfS programmes that are well designed and taught, but also EfS professionals who are trained in both content knowledge and pedagogy as well as the evaluation of professional development programmes. He argues that in order to meet this challenge, effective professional development programmes are required.

Professional development is also important for three reasons. Firstly, because it is a new learning area and included in very few initial teacher education degree programmes in New Zealand (Chapman et al., 2006), professional development is necessary for practising teachers to gain both the knowledge and skills needed for its teaching (Kennelly, Taylor & Jenkins, 2008). Kennelly et al. and Stevenson (2007b) argue that professional development is also necessary because translating the policy rhetoric and principles of EfS into one's pedagogy is a difficult task given the complexity of environmental issues and the abstract nature of concepts such as sustainability. Finally, according to Cross (1998), if teachers do not have a clear understanding of sustainability, they could send their students confused messages.

There seems to be three issues around professional development for teachers: that is its unpredictable effects on children's learning; an identification of the most effective type of professional development; and the challenge of measuring its effectiveness. According to Timperley, Wilson, Barrar and Fung's *Best Evidence Synthesis* (2007), one significant issue is that undertaking professional development does not necessarily result in the desired effects on students' learning. According to Timperley et al. (2007), one reason for this is that teachers respond to professional development opportunities in a variety of ways, some of which can result in student learning that is contradictory to the goals of the curriculum or even society (Timperley et al., 2007). They argue that this variety of responses is because teachers already possess their own theories of education that affect the way they implement the curriculum and how they shape their pedagogy. Stevenson (2007b) holds a similar idea and argues that such theories are implicit and subconscious and act as a lens through which new policies and information, such as that offered during professional development, is processed and enacted in the classroom. Consequently, any information provided through professional development programmes will be interpreted in the light of their personal theories. Therefore, according to Timperley et al., the key to professional development that results in effective student learning seems to be the fostering of self-regulatory behaviour in teachers. Teachers need to be able to inquire into their own practice so that they can assess its impact on students' learning and then make changes to their practice as is required. Knowing how a curriculum area's knowledge progresses as well as appropriate pedagogy to advance this progression is also needed. Consequently, Stevenson believes there has been a shift from trying to change teachers, to viewing teachers as active in their own

learning and growing professionally through reflecting on both their own pedagogy and their participation in professional development opportunities.

When designing professional development programmes, it would be useful to know what type of programme is effective, whether it be listening to inspiring speakers, attending a one-off workshop or engaging in professional development over time. Timperley et al. (2007) have found no one type of programme as being particularly effective that results in change in children's understandings. This situation means that there is scope for investigating what type of EfS professional development can make a change in teachers' pedagogical content knowledge and perhaps develops children's understandings.

Another issue according to Desimone (2007) is the challenge of measuring the effectiveness of professional development. Measuring its effectiveness is important because professional development is often the vehicle of education reforms that need measurable outcomes. Consequently, there have been calls for more empirically valid ways of investigating professional development in order to understand the success or failure of education reform. Arguing from a positivist perspective, Desimone proposes a research-based model for measuring effectiveness that is comprised of two dimensions, namely five characteristics and a "theory of action" (p. 184). She asserts that five characteristics form the central elements of professional development and these are:

- Content focus – developing subject knowledge and knowledge about how students learn
- Active learning – teacher engagement in active learning rather than a passive lecture-type approach
- Coherence – how consistent the teacher learning is with a teacher's currently held beliefs and knowledge
- Duration – professional development programmes continuing long enough to effect change but the duration is not indicated
- Collective participation – having teachers from the same team or school participating so that opportunities for discussions are set up

(Desimone, 2007)

These five characteristics are then placed in a four step theory of action (Desimone, 2007). Firstly teachers experience professional development which contains the five core characteristics. It is hoped that their knowledge and skills are increased or their attitudes and beliefs change. Next teachers implement this new knowledge and skills or changed attitudes and beliefs into their pedagogy. Finally, these changes might result in improved children's learning. Desimone notes that the theory of action occurs within a nested system of complex factors consisting of the characteristics of teachers and children, the curriculum, leadership within the school and governmental policy.

Desimone's model provides an approach to measuring the effectiveness of professional development and its subsequent effect on children's learning. Consequently, there is space for researching whether this model could measure the effectiveness of EfS professional development.

Guskey (2002), another tertiary educator from the United States, has also developed a way of evaluating the effectiveness of professional development by gathering five levels of information of increasing complexity. Level 1 asks for the participant's reactions while Level 5, the most complex level, calls for information about effects on children's learning. Guskey's model has similarities to Desimone's model (2007), such as a focus on content knowledge developed by the teachers taking part and this new knowledge being incorporated into teachers' pedagogy. It is significant to note that both models recognise that the outcome of professional development is improvement in children's understandings. However, Guskey's evaluation does not take account of the stages of professional development which Desimone's theory of action does. Instead Guskey's evaluation poses a series of questions. It seems important to take account of the stages because then an evaluation can be made of the entire process, rather than just parts. For this reason, Desimone's model will be used in this project to measure effectiveness of teacher professional learning.

Since 1999, five professional development programmes have been offered by the Ministry of Education to support the implementation of EfS programmes with three having been formally evaluated. Two professional development programmes designed to assist schools with the development of their EfS programmes were funded by the Ministry of Education during the period 1999 to 2002. These were:

- *Environmental Education Professional Development* (coordinated by the Christchurch College of Education)
- *Professional Development for Sustainable Organic School Gardens* (coordinated by Massey University and the Soil and Health Association of New Zealand)

Only a limited number of schools took part because participation was dependent upon the interest of individual schools. A total of 64 selected pilot schools took part in the first programme. The second programme, *Sustainable School Organic Gardens*, involved 24 urban schools and 12 kura kaupapa (Maori language immersion schools) (Eames et al., 2008).

Since 2002, three further programmes have been funded by the Ministry:

- The Enviroschools Programme (The Enviroschools Foundation, n.d.)
- The NEfS Programme (Eames et al., 2010)
- *Matauranga Taiao* (Eames et al., 2010)

All three programmes offered professional development to a range of schools to assist teachers to plan, teach and assess EfS. The Enviroschools Programme began as a local government initiative in the 1990s. It is now a charitable trust and has a national office which supports a regional and local structure to deliver professional development to early childhood centres as well as primary and secondary schools (The Enviroschools Foundation, n.d.). The NEfS Programme, or National Education for Sustainability Team, evolved out of the earlier *Environmental Education Professional Development* programme and offered professional development to primary and secondary schools. The last programme, *Matauranga Taiao*, began in 2007 and was tailored for Maori-medium education. Its coordinators assisted kaiako and Resource Teachers of Maori to develop EfS programmes that focus on traditional Maori knowledge and concepts in local contexts (Eames et al.).

Recently, the Ministry of Education commissioned a formal evaluation of these three programmes. The findings of the Enviroschools and NEfS Programmes were very encouraging in terms of teachers' perceptions of their ability to plan and teach EfS programmes. For example, 86% of the teachers who participated in the Enviroschools Programme strongly agreed/agreed that they now knew how to run an EfS unit of work. Of those teachers surveyed from the NEfS Programme, 80% of primary teachers and 62% of secondary teachers strongly agreed/agreed that they could now run an EfS unit (Eames et al., 2010).

Teacher perceptions of student outcomes were also very positive. For example, when facilitators and teachers engaged in the Enviroschools Programme were asked about their perceptions of student outcomes, 80% strongly agreed/agreed that students had developed knowledge about their biophysical environment. A similar perception was also held by the teachers in the NEfS Programme with 80-89% strongly agreeing/agreeing with this statement (Eames et al., 2010). Focus group interviews were carried out with very small groups of students (5-6 students in each group) in four schools about their learning and it was the opinion of the authors that data from these interviews backed up the findings from the teachers surveyed (Eames et al.).

The evaluation of the *Matauranga Taiao* Programme revealed that progress had been made in terms of students and communities co-constructing knowledge, the development of support networks and the incorporation of *Matauranga Taiao* into learning programmes was beginning to take place (Eames et al., 2010).

While these findings are very positive, they need to be interpreted with caution. The reason for caution is that these findings are based on the perceptions of the facilitators and teachers and not considered against a conceptual framework such as Desimone's (2007). Timperley et al. (2007) assert that while getting teachers to rate their satisfaction with the professional development is the most commonly used measure of success, teacher satisfaction or "happiness quotients" (Guskey, 2002, p. 3, para. 2) cannot be regarded as evidence because there is no independent verification or triangulation that their perceptions were valid and resulted in improved outcomes for their students. While Timperley et al.'s assumption was not related to EfS professional development,

their stance can be extrapolated to the EfS findings. Furthermore, these EfS student findings came from a very small group of students in just four schools. In addition, the data was gathered from interview only and not from samples of work that had been independently analysed and triangulated.

Eames et al. (2010) do acknowledge the difficulties associated with assessment of student outcomes in EfS and argue that the challenge when assessing EfS student outcomes lies in the way that the outcomes are both public and personal. While there are good models for teachers to assess outcomes related to skills and knowledge that are public, it is far more difficult to assess personal outcomes that relate to a student's values, attitudes, motivation and identity.

This lack of independent verification and triangulation of the effects of EfS professional development on student outcomes means that there is an opportunity for carrying out research into the effects of EfS professional development both on teachers' pedagogy and on student outcomes. As mentioned before, there is also scope for using Desimone's (2007) research-based framework as a measurement model.

There has been some research internationally into the effects of EfS professional development on teachers' pedagogy and particularly primary teachers'. In England, Summers and Kruger (2003) ran a professional development programme with the aim of developing nine primary teachers' subject and pedagogical knowledge about sustainable development. Summers and Kruger then investigated how the teachers translated their knowledge about sustainable development into their teaching and its effects on children's learning. Based on interviews with the teachers and videotapes of their lessons, Summers and Kruger found that these teachers used some dimensions of sustainable development, such as citizenship, interdependence and the rights and needs of future generations in their learning objectives and teaching points. Even though six children from each teacher's class were interviewed before and after teaching, the findings about the children's learning were not specific because the aim was to illustrate what children's learning in sustainable development might look like. They did indicate that the children had developed a limited understanding of sustainable development and this was often accompanied by an improvement in their vocabularies. No details were provided about what their view of a limited understanding entailed. However, Summers and Kruger did note that following the teaching, many children exhibited an emotional response, such as sorrow, anger and an aversion to pollution when discussing the sustainable development issue that they had studied. But there was only a brief examination of the teachers' potential translation of their understanding of sustainable development into their pedagogy. In addition, there was little analysis of the effects of such translation on the children's learning. It is important to note that the focus in this research was on sustainable development and not sustainability which could limit its applicability.

A further five international studies into the effects of professional development programmes on teachers' EfS pedagogy all report positive gains for teachers such as greater use of interdisciplinary approaches and outdoor spaces, with one, Haney, Wang, Keil and Zoffel (2007),

reporting statistically significant gains in teacher beliefs about their self-efficacy. However, none of these studies report triangulated effects on students' learning about sustainability. Three studies did provide teacher-reported data on student learning that was positive. For example, Australians Kennelly et al. (2008) reported students being able to transfer learning to contexts outside the classroom. In the United States, Powers (2004) discussed the way that students were more academically engaged when working outdoors and Christenson (2004) found that students were encouraged to think critically, develop discussion skills and had increased their environmental vocabulary. While Haney et al. did report statistically significant gains in students' learning, it was in terms of their scientific process skills development and their proficiency test scores in writing, maths and citizenship rather than developing understandings of sustainability. The final study, Riordan and Klein (2010), did not provide any data about children's learning. In short, none of these studies focused on the development of teachers' understandings of sustainability and a translation of their understanding into their pedagogy. Furthermore, no study provided triangulated data about the effects of translation on children's learning. This gap indicates scope for research.

Consequently, there appears to be limited research into the effects of professional development on teachers' understandings of sustainability, subsequent pedagogy and its effects on children's learning about sustainability. Research into this area could provide information about how to develop teachers' understandings of sustainability that could guide the planning and implementation of future professional development programmes. In addition, such research could provide information about the types of knowledge and skills needed by teachers to teach EfS that results in enhanced learning for children. Furthermore, investigations could be carried out to explore the effects of such professional development on children's learning about the concept of sustainability.

This research is being planned with the assumption that as a result of engaging in professional development programmes, teachers can develop new understandings of sustainability. How teachers translate their new understandings into their pedagogy is referred to as pedagogical content knowledge (PCK). The role that pedagogical content knowledge could play in the teaching of EfS will now be examined.

3.7 PCK: The amalgam of content knowledge and pedagogy

Once teachers have developed an understanding of sustainability, they then need to be able to translate it into their pedagogy, or in other words, make it accessible for the children in their classrooms. This ability of teachers to make subject knowledge accessible for young people to learn is what is known as pedagogical content knowledge or PCK (Shulman, 1986). It is essential for effective teaching and learning (Cochran, DeRuiter & King, 1993).

A consideration of the participant teachers' PCK is important in this research project because in order to study how teachers translate their understanding of sustainability, it is crucial to find out how they have interpreted their understanding of sustainability, found different ways of

representing it through classroom activities and adapted their understanding to take into account their children's ability, age and prior knowledge.

However, it is not simply a matter of the transmitting of the translated subject knowledge. PCK is far more complex than this and there appears to be a variety of ideas about the elements that make up PCK. For example, Cochran et al. (1993) view PCK as having four integrated elements and coined the term pedagogical content knowing or PCKg to differentiate their ideas from Shulman's original premise. They argue that the 'g' indicates the organic changing nature of PCK as it is constantly constructed. Their elements that make up PCKg include:

- Pedagogy, such as teaching strategies appropriate for specific subjects, classroom management, planning a coherent series of lessons
- Subject knowledge
- Understanding of student characteristics, such as their ability levels, attitudes and prior knowledge
- Awareness of environmental context of learning, such as the social, political, cultural and physical environment in which the school community is situated

From a Palestinean perspective, Hashweh (2005) posits that PCK is even more complex than Cochran et al.'s (1993) four elements. Hashweh has elaborated on previous PCK conceptions and views PCK as a collection of seven "teacher pedagogical constructions" (p. 274) or TPCs which include elements such as knowledge of resources, of context and of curriculum as well as subject knowledge. It is further argued that these constructions are not static but are acquired when a teacher repeatedly teaches a particular topic.

However, neither Cochran et al. (1993) nor Hashweh (2005) specifically mention the role of academic and research knowledge in PCK or the way that teachers develop their PCK when engaging in critical reflection or professionally theorising with their colleagues. Barnett and Hodson (2001), coming from a science education perspective, have included these elements into their model of PCK. They coined the term pedagogical context knowledge or what could be termed as PCxK, to refer to the way that effective teachers make subject knowledge accessible to learners (Barnett & Hodson). Like Cochran et al. (1993), their PCxK also contains four elements that interact and overlap each other, namely:

- Pedagogical content knowledge (knowledge about planning, teaching concepts and ideas and classroom management)
- Classroom knowledge (particular knowledge teachers have about individual learners in their class and ways of managing their learning)
- Professional knowledge (knowledge gained about teaching through unconscious reflection and peer discussions and is specific to a particular school)

- Academic and research knowledge (content knowledge and knowledge about how people learn often based on reflective inquiry)

What differentiates their ideas about PCK is that they view their PCxK as being developed by teachers both as individuals critically reflecting on their pedagogy, but also developed through discussions and interactions with their colleagues as they professionally theorise about their teaching (Barnett & Hodson). This professional theorising is the most important aspect of Barnett and Hodson's conception of PCK.

Therefore, because Barnett & Hodson's (2001) model includes more than subject knowledge, knowledge about how to teach, characteristics of students and students, incorporating critical reflection and professional theorising with colleagues as well, their model of PCxK will be used in this project. The inclusion of critical reflection is important when teaching and learning about sustainability because it empowers learners to reflect on the underlying power structures in society and with this knowledge, they could become advocates of change (Tilbury & Cooke, 2005). In addition, the inclusion of professional theorising with colleagues is considered important because this type of activity could lead to change in a teacher's pedagogy. Finally, there is relevance for using their model because it has only been used in a science education context. Its use in an EfS context as planned in this project might lead to an understanding of the types of strategies and processes used by teachers to translate their understandings of sustainability into their pedagogy.

There appears to be a space for researching how PCxK affects learning in EfS programmes because there seems to be a paucity of research into this particular facet of EfS teaching and learning. While Corney and Reid (2007) analysed geography student teachers' conceptions of the pedagogy in EfS, their study focused on student teachers' knowledge about approaches for teaching EfS together with assessing their awareness of geography pedagogy and the potential for cross-curricular work in EfS. They did not examine the translation of understandings into pedagogy and its effects on children's learning.

In Australia, Skamp (2009) investigated the levels at which six primary teachers used their school's landscapes, or ecological spaces where students can engage in environmental interactions as part of a learning programme. Skamp developed a comprehensive typology to analyse these teachers' level of landscape use that was based on aspects of PCK. He then placed the teachers according to the typology's criteria through an analysis of the changes that they had made to their pedagogy. This research study was based on landscape use and the way it changed teachers' pedagogy. A point of difference in this research would be that it is investigating teachers' use of the concept of sustainability and how it impacts on teachers' pedagogy. In addition, Skamp did not report effects on children's learning. Even though one of Skamp's teacher participants incorporated use of the word sustainability into their pedagogy, there is scope for investigating how incorporation of sustainability impacts on teachers' PCK and its effects on children's learning.

In another Australian study, Kennelly, Taylor and Maxwell (2008) investigated the type of pedagogical content knowledge used by a student teacher in an EfS course undertaken during her pre-service education and internship. They found that this student regarded having a focus on a specific issue that incorporated experiences outside the classroom and researching background information, in other words content knowledge, related to this issue as valuable. While this study has identified valuable PCK strategies used in EfS, the majority of New Zealand teachers do not have EfS experience in their pre-service education (Chapman et al, 2006). This lack of research data indicates a gap for investigating the PCK of practising teachers with little understanding of EfS content knowledge and pedagogy. Furthermore, this study was carried out in Australia and it would be useful to research PCK used in a New Zealand EfS context.

Through a survey administered during an international conference related to sustainability, Sherran (2005) investigated the pedagogical methods used when teaching sustainability to tertiary students. From 22 completed surveys, she reported that experiential activities outside of universities such as community-based outreach and field-based case studies were regarded as most appropriate. Discussion, debate and presenting seminars about problem-based research were also regarded as valuable. However, this study investigated tertiary education pedagogical methods for teaching about sustainability and not primary education ones, so there is scope for research into pedagogical methods that would be valuable for primary school teachers to use in their EfS programmes.

There is some New Zealand research on children's learning of sustainability. In my master's thesis, I investigated the way in which 22 children aged between 11-12 years of age developed an understanding of sustainability. However, this research only focused on children's understandings of sustainability. While identification of teaching activities that had a high impact on the development of understanding was made, there was no investigation into the translation of the teacher's understanding of sustainability into her pedagogy. Therefore, there is scope for research to be carried out into the strategies used by teachers to translate their personal understandings of sustainability into their pedagogy.

Consideration needs to be given as to how teachers might develop an understanding of sustainability in order to plan for effective professional development programmes. It is proposed that transformative learning theory could provide a theoretical framework to explain development of understanding about sustainability. This theory is discussed in the next section.

3.8 A theoretical framework for learning about sustainability

It is proposed that transformative learning theory could be used as a theoretical framework for developing an understanding about sustainability. The reason for its choice is that learning about sustainability is intended to result in ontological change and transformative learning theory fosters such change. It is hoped that as people develop an understanding of sustainability and begin to implement their understandings into their lifestyle choices, they could start to change the ways in which they think, live and work (Tilbury, 2004). Learning about sustainability aims to change

values and beliefs at a deep level by encouraging learners to reflect on their lifestyle choices and the way in which society is structured (Sterling, 2010). This movement from a narrow perspective to one where there is the potential to make more sustainable choices is an essential objective of sustainability and EfS programmes (Fien & Tilbury, 2002; Tilbury).

Transformative learning theory fosters ontological change through challenging existing beliefs and values, exploring alternative possibilities, transforming the existing beliefs and values, thus enabling the person to act on the new belief (Mezirow, 1990). In a critical review of transformative learning research, Taylor (2007) argues that this theory is effective in encapsulating the way that adults engage in meaning making, especially when paradigmatic shifts are involved. Mezirow had also incorporated this idea and argues that transformative learning is analogous with Kuhn's concept of a paradigm shift. He gives the example of the women's movement in the last half of last century where many women challenged their sex-stereotypical roles and re-defined their role in society as being an example of transformative learning. This theory consists of three central components, namely the construing of meaning, critical reflection and rational discourse (Mezirow, 1990; 2003). Each of these elements will now be discussed in terms of developing an understanding of sustainability.

The first element is the construing of meaning. It is central because it is seen as the making of a new or a revised interpretation of the meaning of an experience which guides subsequent understanding, appreciation or action (Mezirow, 1990). Our interpretations of experiences are structured by a set of assumptions, or habits of expectation, and these are developed through cultural assimilation and socialisation. An example of a set of assumptions in terms of sustainability is the way that many people perceive sustainability as involving the environment and do not consider that society and the economy also form part of this concept.

Presenting ideas that challenge existing habits of expectation, such as finding out about the ways in which society and the economy interrelate with the environment, could result in people experiencing cognitive dissonance. Cognitive dissonance can be regarded as a negative drive state that occurs when a person holds two ideas, beliefs or opinions that are cognitively inconsistent (Aronson, 1969). This is seen as an unpleasant situation so a person will work towards reducing this dissonance by either adding consonant cognitions, in other words justifying one's differing ideas, or else by changing one or the other idea, or even both, to make them fit together or become more consonant. In this way people are viewed as rationalising beings, rather than being rational (Aronson).

This aspect of transformative learning could be used to explain how teachers could develop their understanding of sustainability. As the teachers engage with the activities and discussions during the workshops, they might experience cognitive dissonance. As they work to reducing this dissonance, they might make a new or revised interpretation of sustainability. Consequently this new or revised interpretation could then be translated into their classroom pedagogy when teaching EfS.

The second element is critical reflection. The concept of reflection was first coined by John Dewey (1997) who defined it as a person considering a belief or type of knowledge in terms of its supporting grounds and also considering conclusions which arise as a result of such a belief or knowledge. However, in Mezirow's transformative learning theory (1990), the central role of critical reflection is to transform learners' perspectives through challenging the validity of presuppositions in prior learning which make up our habits of expectation. Also, critical reflection provides the learner with opportunities to question their habits of expectation and the structures that they use to make meaning of the world setting up the possibility of creating cognitive dissonance (Mezirow, 1990; Taylor, 2007). These researchers assert that learners need time to re-assess their habits of expectation and, if necessary, transform them. Hence, critical reflection is not about how or how to, it is about why and the reasons for and consequences of what we do. In this way transformative learning is about challenging habits of expectation and exploring alternative perspectives, which may lead to the transformation of old ways of understanding and action being taken on new perspectives.

Again this element of critical reflection could explain how people develop an understanding of sustainability. Learning about the definition of sustainability that has been developed for this project could well challenge the teachers' existing ideas about sustainability. When given an opportunity to reflect on and explore this alternative view about sustainability, teachers might transform their existing ideas. In addition, reflecting on their ideas about sustainability could also give teachers the opportunity to reflect and re-assess their own personal values and think about making changes to their pedagogy (Nolet, 2009).

The third element of transformative learning theory is rational discourse. Rational discourse is important because transformative learning can be regarded as "communicative learning", a type of learning where you need to be able to understand what someone means when they communicate with you, including their assumptions and habits of expectation (Mezirow, 2003, p. 59). As this type of communication or rational discourse occurs, you are assessing the authenticity, appropriateness and beliefs of others in order to arrive at a judgement of some kind. This process is referred to as "critical-dialectic discourse" and this dialogue with others is an essential part of critical reflection (Mezirow, p. 59; Taylor, 2007). In this way, transformative learning theory is grounded in the nature of human communication and could be linked to elements of Barnett and Hodson's (2001) PCxK.

This study will provide the opportunity to explore the potential of rational discourse in the form of discussions to foster changes in the teachers' understandings of sustainability. In addition, this rational discourse is important to the researcher because it is the outward manifestation of any changes to their understandings of sustainability and could provide her with a way of interpreting these teachers' pedagogy.

Finally, this theory appears to have the potential to explain any changes that take place in the teachers' understandings because research has shown that transformative learning theory can be

used to explain the process by which people's worldviews undergo paradigmatic shifts (Taylor, 2007). However, there have only been few studies that have reported transformation of perspectives that resulted in ontological change (Taylor). One example of such a study was by Lange (2004) in her study of 15 Canadian adult participants who were facing pivotal points in their lives (e.g. starting a new job) and attending an adult education course. Lange reported that many participants underwent an ontological change during the course, where the way that they perceived their world and their relationship with it changed. For example, many participants reported a shift from the "mode of having to the mode of being" (Lange, p. 132). This phrase referred to the way that many participants stopped viewing their success in life in terms of accumulation of material possessions and instead focused on people and their relationships with people. Others changed their patterns of consumption through the purchase of goods produced locally and with social justice in mind. Five years on from the initial study, many reported that they were involved in voluntary and community-based projects. However, Lange's study had a different focus from this research project and there is potential for research into investigating whether the teacher participants' understandings of sustainability deepen and, as a result, they show evidence of ontological change.

If the teacher participants in this study do undergo ontological change as a result of developing an understanding of sustainability, then such change could impact on their identity as a teacher of EfS. This impact could occur because learning affects one's identity (Brickhouse, 2001). As a person learns, they have a vision of what or who they want to become, and develop strategies to move towards that goal that results in a change to their identity. This thesis postulates that people's identities are expressed in the way that people see themselves and in their actions. Consequently, the issue of teacher professional and personal identity will be examined in the final section of this literature review.

3.9 Teacher professional identity

Cohen (2010) notes that teacher professional identity is an emerging field of research and is considered important because a teacher's experiences and images of self strongly influence their pedagogy, their development as a teacher and their response to changes in education. Gee (2001) agrees with its importance and regards identity as an significant "analytic tool" in educational research (Gee, p. 99).

Considering teacher professional and personal identity is important in this project because learning about sustainability could have an impact on the teacher participants' identities. This impact could come about because teachers' personal lives intersect with their professional lives and if their beliefs and values change as a result of their deepened understanding of sustainability, they could view their pedagogy differently. Consequently, consideration of a teacher's personal life is important when studying teacher identity because there is a close association between one's personal and professional self (Thomas & Beauchamp, 2011). Such a close association could be important when exploring teachers' identities related to their EfS

teaching because a person's experiences of nature are regarded as one of the influential "entry-level variables" that can affect a person's interest in nature and their willingness to take action to protect it (Chawla & Cushing, 2007, p. 440). Subject affiliation also affects teacher identity (Helms, 1998) and it is proposed that when teachers begin to teach sustainability, they might feel more affinity towards its teaching, which could affect their identity. Finally, studying teacher identity is important because identity and learning are intertwined. Learning about sustainability could change their ideas and they could envisage themselves in different ways. Thus, as they work to be that different person, their identity could change.

This section is divided into two parts. In the first part, Gee's (2001) four different perspectives of identity are discussed with examples. In the second part, teacher professional identity is considered in relation to Gee's identity perspectives and its importance in this project is also discussed.

3.9.1 Types of identity

Many researchers agree that identity is a complex construct because it is not static, but fluid as a person's identity develops over one's lifetime (Beijaard, Meijer & Verloop, 2004; Enyedy, Goldberg & Welsh, 2006; Helms, 1998). Gee (2001) puts forward the idea that people have multiple identities and identity can be defined as being a particular type of person in a particular context and being recognised by others as that particular type of person. He has identified four perspectives of identity that are interrelated. All of these perspectives might co-exist but at any one point in time, societies highlight one.

The first identity perspective is the nature perspective or N-Identity. The N-Identity is a state that a person is in, for example their ethnicity. It is determined by a force, such as one's genes and is controlled by nature, not the individual or society. However, N-Identities gain their power through the work of institutions, the discourse and dialogues used by people in a society and through affinity groups (Gee). For example a person might have an N-Identity as a Maori (first people of New Zealand) based on their genetic heritage. This N-Identity can gain force if this person has access to their whakapapa (ancestral lineage) through their kaumatua (elders) and have a place on their iwi's (tribe) marae (meeting place). This person's identity can also be strengthened if they register as a Maori voter when participating in elections and can then elect a Maori representative to be part of the next government. Their N-Identity can also gain force if this person chooses to join a kapa haka group to perform Maori music and dance. They might respond to learning during an EfS programme as Maori using *Matauranga Taiao* (environmental knowledge). In these ways, this person's identity is both created and maintained by people recognising them as Maori.

The institutional identity or I-Identity is the second perspective described by Gee (2001). This perspective relates to a position that is determined by an institution or set of authorities. The position is conferred upon a person according to laws, rules or traditions and these same laws, rules or traditions of the institution set and maintain the standards of the position (Gee). An example of an I-Identity is when a person wins a teaching position in a school. The principal and

Board of Trustees decide that that particular person is suited for the position and appoint them. The position conferred is that of a teacher and the individual gains an I-Identity as a teacher. However, it is up to the individual as to how actively they fulfil their I-Identity as a teacher and it is the principal of a school who is responsible for monitoring the effectiveness of its teachers. But it is other institutions, for example in New Zealand the New Zealand Teachers' Council, who set the standards in consultation with other institutions, such as governments, universities and teacher unions. In this way, institutions are both creating and maintaining this perspective.

The discursive identity, or D-Identity, is the third perspective (Gee, 2001). Unlike the previous two perspectives, people are neither born with a D-Identity nor is it conferred upon them. Instead this perspective is an individual trait and its source of power is the dialogue and discourse of other people. It is other people who recognise one's D-Identity and maintain it and an institution is not needed to sanction this identity perspective. An example of this perspective is being a world renowned conservationist like Don Merton. Here fame is not inherited or conferred by an institution. Instead it is gained by being recognised through one's actions and words by other people in a society. Don Merton, for example, is famous for bringing endangered birds such as New Zealand's kakapo and the South Island saddleback back from the brink of extinction (Fitter, 2011). He is most well-known for his rescue of the Chatham Island black robin, once the most endangered bird in the world (Fitter). His innovative techniques developed to manage endangered birds, such as capture and translocation together with cross-fostering have been used worldwide (Fitter; NZPA, 2011). During his life he published over 145 books, articles and scientific papers (NZPA). This recognition is then reinforced through the dialogue and discourse about his ideas, books and life through media. The D-Identity of being a famous conservationist can also be recognised by institutions, such as being the recipient of the Royal Society of New Zealand's Fleming Award for Environmental Achievement in 1990 (Fitter). Merton also received international recognition with the United Nations Environment Programme electing him to the Global 500 Roll of Honour in 1998 (NZPA). In this way, the interrelationship between identity perspectives can be seen. The D-Identity is recognised in such a way that it then becomes an I-Identity as well. Like the I-Identity, it is up to the individual concerned as to the degree to which the D-Identity is taken up. This can be seen in the example of Don Merton. He chose to use his D-Identity to publicise his ideas about rescuing endangered birds and as a result, his techniques are used worldwide.

The final perspective is the affinity perspective or A-Identity (Gee, 2001). One's A-Identity is made up of characteristic experiences and practices and the source of power for this identity perspective is an affinity group. An affinity group is defined as a group of people who share a common interest and this group must provide people with access and opportunities to participate in its distinctive practices so that they have access to the necessary affinity group experiences (Gee). Thus it is the sharing or participating in the particular affinity group's practices that creates and maintains a person's A-Identity. People must choose to belong to an affinity group and can have multiple A-Identities.

In today's world there are many examples of affinity groups through which people create and maintain A-Identities. Societies and clubs are examples and New Zealand's Forest and Bird Society is one (Forest and Bird, 2011). People pay a subscription to belong and receive a magazine with articles and advertising particularly aimed at this group. Local sub-groups organise activities, such as restoration of riparian regions of streams and lectures by conservation experts for their members to attend. Members also engage in political lobbying when conservation issues arise, such as the mining of dedicated national park areas or plans to construct hydroelectric dams. Such activities give people the opportunity to experience and participate in the distinctive practices of this affinity group, which maintains their A-Identity.

The way in which these identity perspectives impact on teachers' professional and personal lives will now be discussed.

3.9.2 Teachers and their professional identity

These identity perspectives impact on teachers as they work with students, parents, other teachers and professionals within their school, parents and the wider community (Clandinin & Connelly, 1995). Consequently, Helms (1998) argues that research into how identity impacts on teaching practice brings a completeness to our understanding because teachers do not only live in their classrooms and schools, they also have a life outside of school. Helms also states that if only a teacher's practice is investigated, then researchers run the risk of incorrectly representing the "teacher *as* practice" (Helms, p. 831) and a teacher is more than their practice, they are the whole person.

It is generally accepted that teachers are situated within a "professional knowledge landscape" (Clandinin & Connelly, 1995, p. 4) which is an intersection of their personal and professional lives (Beijaard et al., 2004; Cohen, 2010; Enyedy et al., 2006). This intersection is important when exploring identity because Thomas and Beauchamp (2011) argue that there is a close, if not inseparable, association between one's personal and professional self. In addition, it is within this landscape that teachers engage with students, peers, other professionals, parents and other people in their community and through their social interactions in such settings, their identity is developed (Beijaard et al.). Three of the above identity perspectives can be related to teachers in such a landscape. Firstly, the position of teacher has been conferred upon them creating an I-Identity for each teacher. Teachers also have a D-Identity because others, both within their community and in society at large, engage in discourse and dialogue that recognises them as teachers because of their words and actions. Because they are recognised as teachers, they are treated and talked about in a particular way, which serves to maintain their D-Identity. Finally, Gee (2001) maintains that schools are a particular type of affinity group, which serve to create and maintain teachers' A-Identities.

Teachers' A-Identities are maintained through the particular experiences and practices of particular schools. Each school has an individual culture as an affinity group with particular practices. Such practices include having a vision for their learners, creating communities of

learners in classrooms that use particular styles of learning, for example inquiry-based learning, and some schools also are part of international educational programmes such as the International Baccalaureate, Edmund Rice tradition or Rudolf Steiner. Schools engage in bonding activities to foster allegiance to the affinity group such as going on camps, entering sports teams in regional sports events or participating in competitions such as science and technology fairs and literature quiz events. In these ways, teachers participate in the requisite experiences which maintain their A-Identities.

Exploring the intersection of teachers' professional identity and learning about sustainability is important in this research project for two reasons – subject affiliation and learning. Firstly, Enyedy et al. (2006) and Helms (1998) argue that subject affiliation, or a teacher's relationship with the content of a particular learning area, is a powerful part of teacher identity, especially if the affiliation is to a subject of high academic status, like science. Subject affiliation is also an important facet of a teacher's identity because it helps to encourage feelings of belonging to a particular community (Pedretti, Bencze, Hewitt, Romkey & Jivraj, 2008), for example an EfS community. Helms goes further, stating that not only does subject affiliation impact on what teachers choose to include in their classroom programmes, teachers also connect the subject to other parts of their lives, reinforcing Thomas and Beauchamp's (2011) notion of the close association between a teacher's personal and professional lives.

However, teachers are more likely to have multiple identities (Brickhouse, 2001; Enyedy et al., 2006; Helms, 1998). Beijaard et al. (2004) refer to these as sub-identities which relate to a teacher's different relationships and contexts in which they interact and note that some of these sub-identities are more central to a teacher's identity than others but they must all be well-balanced. Wenger (1998) concurs with this notion of having multiple identities but refers to it as having multimembership in different communities with a person being a full member of some and only a peripheral member of others. This analysis concludes that a person's identity is at the 'nexus' of this multimembership, requiring each person to reconcile the demands of different forms of membership in order to construct a coherent identity (Wenger). Thus, Beijaard et al. and Wenger argue that it is a struggle to maintain coherence or balance in one's identity when crossing the boundaries of the different groups or communities in which a person participates.

Due to the fact that New Zealand primary teachers are required to teach across all learning areas, it could be that primary teachers have a sub-identity dependent upon their affiliation to each learning area and that teachers might have a stronger affiliation and sub-identity to particular learning areas. Given that subject affiliation is an important part of teacher identity, it could be that learning about sustainability raises its importance in teachers' perceptions, which could lead to them including the concept of sustainability in their classroom programmes and incorporating more sustainable practices into their life in and outside of the classroom. In other words, learning about sustainability might result in teachers feeling a stronger affiliation towards EfS, resulting in a change to their identity.

The second reason why investigating teacher identity could be important relates to the relationship between identity and learning. Helms (1998) argues that learning is intertwined with identity because identity is made up of four dimensions that are different to Gee's (2001): one's actions, what one thinks that others expect of them; one's values and beliefs, and the kind of person that one wants to be. Helms and Brickhouse (2001) also state that while these four dimensions all flow through one's values and beliefs, one's "sense of becoming" or "futuring" (Helms, p. 830) is the dimension that relates to learning. A person's sense of becoming refers to the way that one envisages the type of person they want to become and then work towards that goal by learning the specific traits or practices that the desired type of person possesses. When viewed in this way argues Brickhouse, learning is not something that just happens in a specific place like a school or university, it happens all the time and is unavoidable. Furthermore, Wenger (1998) also views learning as transformational since it changes who a person is and what they can do. It is also similar to creating and maintaining an A-Identity and in this way people's identities are changing and developing as they live their life.

This view of learning as contributing to identity formation is important for this research project because the teachers are learning about the concept of sustainability. Such learning could affect their sense of becoming and thus result in them wanting to incorporate new ideas into their pedagogy or into their personal lives, which will be a change in their identity and the way they perceive themselves as a teacher.

There is some research into the role and development of teacher identity (e.g. Beijaard et al., 2004; Cohen, 2010) and science teachers' professional identities (e.g. Brickhouse, 2001; Enyedy, 2006; Helms, 1998) but very little research has been done into the identity of teachers teaching about sustainability. Kennelly, Taylor and Maxwell's (2008) study of an early career teacher's experience of teaching EfS did investigate her identity. They were able to make links between her early life experiences in the environment and her expressed values about the environment that resulted in a "love of the land" (Kennelly et al., p. 31). They argued that her experiences and values empowered her to legitimise her positive environmental values and include them in her teaching programme. However, this was a study of one teacher who was beginning her career and there is scope for more research to find out whether other teachers are also able to legitimise their environmental values into their pedagogy. Also, there was no mention about this teacher's understanding of sustainability and its effects on her identity, so there is further scope for research into this aspect.

Hwang (2008) investigated five South Korean science teachers' beliefs about their teaching and the ways that they incorporated environmental education into their teaching. Through this investigation, she was able to explore boundary lines, one that lay between their mandated teaching and what they want to do and can do and the other line, that if crossed, put these teachers in a vulnerable position where their professionalism as teachers could be questioned by students and the administration. As a result, she found that their science teacher identity was 'permeable' to environmental education. However, this study was set in South Korea with a very

different education system to New Zealand and also investigated specialist science teachers, so there is a gap here for exploring New Zealand primary teachers', who are generalist teachers, identities as teachers of EfS.

In summary, identity is regarded as an important construct when exploring teachers' pedagogy because it is an expression of their self-perceptions and experiences. A teacher's identity can also be regarded as an intersection between their personal and professional lives. Gee (2001) proposes that identity can be viewed through four different perspectives, three of which could be relevant to this project. The researcher has proposed that subject affiliation that could lead to a sense of belonging to a community affects a teacher's identity. It is also proposed that learning can impact on a teacher's identity as they envisage the type of person they wish to become and work towards that goal.

These two literature review chapters have argued that it is important for teachers to have an understanding of sustainability to enable them to teach EfS programmes. Teaching EfS is seen as critical to bringing about change that could lead to an equitable lifestyle for all people and a halt to environmental degradation. However, sustainability is a complex and contested concept. Its complexity makes it very difficult for people to understand and because teachers need to have an understanding of this concept to be able to teach it, ways of developing an understanding through professional development need investigation. In order to measure the efficacy of such professional development, its impacts on children's understandings of sustainability need to be explored. Such data would then provide evidence of triangulation of the professional development's effectiveness. Finally, there appears to be a close link between a teacher's professional role and their identity that warrants exploration using the lens of being a teacher of EfS. Therefore, this research aims to investigate the following questions:

1. What are student and practising primary teachers' understandings of the concept of sustainability?
2. How can student and practising primary teachers' understandings of sustainability be developed?
3. How do the practising teachers translate their personal understandings of sustainability into their pedagogy?
4. How do the children in the practising teachers' classes express their understanding of sustainability following an EfS programme?
5. How does their understanding of sustainability affect student and practising teachers' sense of identity as EfS teachers?

Chapter 4: Research Design

4.1 Introduction

This project had five questions that guided the direction of the research:

1. What are student and practising primary teachers' understandings of the concept of sustainability?
2. How can student and practising primary teachers' understandings of sustainability be developed?
3. How do the practising teachers translate their personal understandings of sustainability into their pedagogy?
4. How do the children in the practising teachers' classes express their understandings of sustainability following an EfS programme?
5. How does their understanding of sustainability affect student and practising teachers' sense of identity as EfS teachers?

This chapter discusses the interpretivist methodology and case study approach chosen for this project in Section 4.2 and the research design is described in Section 4.3. Section 4.4 outlines the manner in which the sampling and selection of participants took place. The people involved in this project are introduced in Section 4.5. The three sources of data generated are outlined in Section 4.6 and the way in which these data were analysed is discussed in Section 4.7. Section 4.8 addresses issues of trustworthiness and this chapter concludes with a discussion of ethical considerations pertinent to this project.

4.2 Ontological, epistemological and methodological frames of this research

This research project used an interpretivist methodology with a case study approach. An interpretivist methodology that is located in the qualitative paradigm was chosen because it holds that there is no one objective reality or truth. Instead, people construct their own reality through their interactions with their world and the researcher aims to represent their interpretation of the participants' realities. Because people construct their own reality based on their experiences and interpretations of those experiences, there are multiple constructed realities (Neuman, 2003; Sarantakos, 2005). The existence of multiple realities means that there can be no single definition of sustainability held by every person. Therefore, this methodology allowed me to gather and analyse a range of ideas about sustainability and levels of complexity of understanding within those ideas held by the teacher participants (referring to both student and practising teachers) and children in this project. Interpretivist methodology also permitted me to gather and

analyse data that showed a range of levels of identity as EfS teachers among the teacher participants.

The ontology that framed this study is constructionism. This ontology holds that reality is constructed by people through engagement in an active process, as they interact with their world. Such construction is also based on people's interpretations of their experiences (Neuman, 2003; Sarantakos, 2005). Given that the construction process is active, this methodology also allowed me to gather and analyse data related to the way that these teacher participants' understandings of sustainability developed in complexity across the period of the study. This view of reality also enabled me to analyse the way in which the practising teachers translated their understandings of sustainability into their pedagogy.

This constructionist view also regards reality as fluid (Sarantakos, 2005). People are seen as constructing reality and then, through processes of recursivity and reflexivity, re-construct reality as they work to make sense of their world. This aspect of interpretivist methodology links closely to transformative learning theory (Mezirow, 1990), which postulates that people, through the process of critical reflection can change their habits of assumption, leading to a transformation in their worldview. It is proposed that such a transformation was occurring as the teacher participants developed deeper understandings of sustainability in this project. In this way, a constructionist ontology could enable me to gain an understanding of how teacher participants' understandings became more complex.

Furthermore, a constructivist epistemology allows the view that people do not construct reality in a vacuum. Reality is socially constructed through cultural processes such as socialisation (Sarantakos, 2005). A society creates meanings collectively so that they are available for people. Such meanings are conveyed and shared through culture and are maintained and reconstructed by people through their interactions with each other. Therefore, communication is more than an exchange of information, it is a way of generating meaning within a social context (Sarantakos). This aspect of a constructivist epistemology also relates to transformative learning theory. Transformative learning is also known as 'communicative learning' (Mezirow, 2003) because it is grounded in the nature of human communication. One of its three elements is rational discourse, where a person is assessing the authenticity and beliefs of others as they engage in discussion, in order to arrive at some type of judgement. It is an important part of critical reflection because as that person arrives at their judgement, it could lead to a transformation in their ideas. It was also proposed in this project, that such rational discourse could lead to a deepening in teacher participants' understanding of sustainability. In this way, a constructivist epistemology could aid me to interpret the role of discussion in the development of teacher participants' understandings of sustainability and its role in collegial discussions that are a part of pedagogical context knowledge (Barnett & Hodson, 2001).

Recently, there has been recognition of the need to engage in critical and reflexive thought about ontological, epistemological and methodological issues in the EfS research spectrum (Hart, 2007;

Reid & Scott, 2008). This issue has arisen because knowledge in the social sciences is not as clearly defined as in the natural sciences and so there can be problems of interpretation and representation possibly leading to misunderstandings and misinterpretation. Consequently, it is important to justify research findings so that they seem to be plausible, authentic and clear of subjectivity. In this way findings can be shared and understood in an intersubjective manner (Hart). It is, therefore, for these reasons that the ontology, epistemology and methodology framing this project have been discussed and this approach was justified.

4.2.1 A case study approach

A case study can be regarded as an investigation into a phenomenon, issue or concern, or interest in gaining an understanding of the case itself (Merriam, 1998; Stevenson, 2004). Case studies are also seen as a "bounded system" (Merriam, p. 26) because they are set within a specific context. According to Merriam, case studies have three characteristics: they are particularistic, descriptive and heuristic. They are particularistic because they focus on a specific phenomenon, event, situation or programme; descriptive because case studies provide a vivid and full description of the phenomenon being explored, and they are heuristic due to the way that case studies can clarify a reader's understanding of the phenomenon being studied.

This type of approach was chosen for my research project because my project explored the phenomenon of people's understandings of sustainability. Using a case study approach enabled me to explore the participants' representations of reality in the complex situations of the workshops and school by describing and analysing these contexts (Corcoran, Walker & Wals, 2004). It is an appropriate choice because case studies are most often conducted in an interpretivist frame (Stevenson, 2004) and particularly suited to answering 'how' and 'why' questions (Yin, 2009). Also, Dillon and Reid (2004) note that case studies are often used in education for sustainability research as either exemplars with potential for generalisability or else as illustrations of the applied theory in practice.

I also chose a case study approach for the following reasons. Firstly, this type of approach allowed me to focus on a particular bounded programme, namely the workshops, and get as close as possible to the teacher participants so that I could explore how their understandings of sustainability had developed and its consequent effect on their identities as EfS teachers. It also enabled me to focus on the way in which the practising teachers translated their understandings in the context of their classrooms with the school (Merriam, 1998). In this way I was able to gain a holistic view of the effects of the workshops on their translation of sustainability as well as the effects of their understandings on teacher participants' identities.

Using this approach resulted in a "rich, thick description" (Merriam, 1998, p. 29) of how the teacher participants developed their understandings of sustainability and translated it into their pedagogy, giving the reader a strong representation of reality (Stake, 2000). This thick description was also used to illustrate the many factors that affected the development of teacher participants' understandings of sustainability and their identity as well as the complexities of

translating personal understandings into their pedagogy. Consequently, I was able to make a judgement about the efficacy of the workshops on understanding and translation of sustainability into classroom pedagogy.

As a result of using a case study approach, my findings were more contained and likely to resonate with the experiences of other EfS researchers and teachers. In addition, the findings were contextual as the teacher participants' experiences were located in a specific context. Therefore, through a rich description of this case, I aimed to give readers a vicarious experience of the workshops and teaching of the EfS programme (Stevenson, 2004). Consequently, when reading about my findings, readers might see similarities in their experiences and understandings and thus be able to transfer my findings to a comparable context (Lincoln & Guba, 1985).

4.3 Action plan

This research project had three phases. The first phase involved generating data from student teachers about their understandings of sustainability. Then data were collected about the development of student teachers' understandings of sustainability and their growing awareness of its pedagogy. In the second phase, data were generated about practising teachers' understandings of sustainability. Following their participation in the workshops, data were collected about their developing understandings of sustainability and awareness of pedagogy.

The third phase involved data generation through interviewing practising teachers about their translation of sustainability into their EfS programmes and their perceptions of its effects on their children. Next data about the practising teachers' children's understandings of sustainability at the conclusion of the EfS programme were gathered. The final data generated related to the practising teachers' identity as EfS teachers and were obtained through interviews. These three phases are summarised in Table 4.1.

Table 4.1 Summary of the three phases of the research project

Phase	Participants Involved	Data Generation Activity
Phase 1 2008 June – December	Student teachers	Initial questionnaire
		Workshop activities that included a peer interview
		Post-workshop questionnaire Post-workshop individual interview
Phase 2 2010 January	Practising teachers	Initial questionnaire
		Workshop activities that included a peer interview
		Post-workshop questionnaire Post-workshop individual interview
Phase 3 2010 March – November	Practising teachers	Interviews with practising teachers
		Practising teachers' EfS planning
	Children in practising teachers' classes	Interviews with children
		Children's written work
	Practising teachers	Interview with practising teachers

4.4 Sampling and selection

Purposive sampling was used in this research project. The selection of teacher participants began with a colleague approaching a cohort of student teachers who were in their third year of a three year Bachelor of Education primary teaching specialisation degree to invite them to complete the questionnaire. At this point, the student teachers were also invited to participate in the series of workshops.

The selection of teacher participants continued with Hamish (pseudonym), one of the practising teacher participants, contacting me. Hamish had been given my name as someone who could assist him in developing EfS teaching programmes for Seaview School (pseudonym). Following discussions with Seaview's Principal and Hamish, he approached the teachers at Seaview to invite them to participate in the workshops. After the workshops, I invited these practising teachers to continue in my project.

This sampling technique was chosen for my project because I had a specific purpose in mind for this project, namely exploring teacher participants' understandings of sustainability, the possibility of developing their understandings, the translation of their understandings into their pedagogy and its effects on their children (Neuman, 2003). I also wanted to explore the effects of their understandings of their identities as EfS teachers. In addition, purposive sampling was an appropriate technique because I needed a "specialised population" (Neuman, p. 213), namely teacher participants with an interest in sustainability, who would be relevant to my project (Sarantakos, 2005).

The student teachers were approached because I thought that since many would be beginning their teaching career in the next year and as EfS was not a compulsory course in their degree, they might be interested in learning about sustainability and ways of teaching it. Therefore, the criterion for selection was having an interest in sustainability and the teaching of it. The same criterion of having an interest in sustainability was used for the selection of the practising teachers. Being willing to teach an EfS programme and be interviewed at regular intervals by me about their teaching were the criteria for selection to continue in the project following the workshops. The practising teachers' children were selected on the basis of being members of their classes, having been given consent to participate by their parents/guardians as well as having given their assent to participate in the interviews.

4.5 People involved

There were three groups of participants involved in this project, namely student teachers, practising teachers and the practising teachers' classes of children. The profiles of each group will now be discussed in turn.

4.5.1 Student teachers' profiles

The student teachers who completed the initial questionnaire were completing a compulsory course in the second semester of the third year of a three year Bachelor of Education (Tchg)

primary specialisation degree. Seventy-seven student teachers out of a cohort of approximately 200 completed the questionnaire. Of these 77, 73% were females and 9% males, with 18% not completing this item. As is shown in Table 4.2, over half of this group were between 20 and 29 years of age. Data about ethnicity were not gathered.

Table 4.2 Ages of student teachers completing the initial questionnaire

Age Range	Frequency (*n*=77)*	Percentage
Less than 20 years	1	1.3
20 – 29 years	51	66.2
30 – 39 years	12	15.6
40 years and over	11	14.3

Note. * two participants did not provide this data

Twenty-one students decided to participate in the workshops, 20 females and 1 male. In terms of age range, 13 of these student teachers were between 20 and 29 years of age (62%), three were between 30 and 39 (14%) and five were aged 40 years and over (24%).

4.5.2 The school's, practising teachers' and their children's profile

This sub-section will only introduce the school, practising teachers and their children because the majority of this information is contained in Chapter 7 for ease of understanding the findings as they are presented. The data for this project was gathered from a single primary school in the central suburbs of Auckland. Although seven practising teachers from 'Seaview' participated in the workshops, two teachers, namely Hamish and Mike, elected to continue with the research. All of the children in Hamish's and Mike's classes participated in the EfS programme. However, only eleven children who returned signed parental consent forms in Hamish's class, a Year 3 class with children aged between seven and eight years of age, participated in the interviews to gather information about their understandings of sustainability. Seven of the children in Mike's Year 1 class with children aged between five and six years of age who had returned the required forms were interviewed.

4.5.3 Relationships with participants

During the course of the workshops, I built relationships with the student and teacher participants. It was important to develop these relationships because people are more likely to share their ideas with you if you are not a relative stranger to them. In order to foster relationships, I tried to be as accommodating as possible in terms of organising times convenient to the teacher participants for the workshops and interviews and I also supplied food and drink. The food and drink seemed to be welcomed by the student teachers.

My relationship with Hamish and Mike was closer than that with the student teachers because I spent more time with them. I interviewed Hamish on four occasions and Mike six times.

However, our interactions were confined to the formal interviews. Firstly I spent some time during the workshops with Hamish and Mike, discussing their ideas about sustainability, their responses to the workshop activities and I also conducted an individual post-workshop interview with them. When I conducted interviews about their teaching, each interview was in excess of an hour long and consequently I learnt about aspects of both their professional and personal lives. I also shared some of my ideas. As a result, when it came time to conduct the last interview about their identities as EfS teachers, they seemed to be very comfortable with me talking about their values and beliefs.

My relationships with the student teachers were not as close. In a similar way to Hamish and Mike, I spent time with them during the workshops, talking about their ideas of sustainability and reactions to the workshop activities. Despite the short amount of time spent with them, they seemed comfortable sharing their ideas with me during the post-workshop individual interview, including ideas about their personal sustainable practices.

4.6 Data generation

Three different types of data were generated in this study. Firstly there was an anonymous questionnaire that was completed by all teacher participants. Interviews were conducted with each group of participants. During the workshops the teacher participants interviewed each other and at the conclusion of the workshops, I interviewed the teacher participants individually. I also interviewed Hamish and Mike during their teaching of their EfS programmes. Finally I interviewed Hamish and Mike's classroom children individually at the conclusion of their EfS programmes. The third type of data gathered were documentary data in the form of Hamish and Mike's EfS planning and Hamish's class of children's responses to a summative task.

4.6.1 Questionnaire

A questionnaire was used at the beginning of this project and again at the end of the workshops. I chose a questionnaire because it allowed me to sample many teacher participants' understandings of sustainability with no variation in the questions (Neuman, 2003; Sarantakos, 2005). It also produced very quick results in a relatively short period of time (Sarantakos). However, I found that a few questionnaires were only partially completed and there was no opportunity for me to interview some of the student teachers who had particularly interesting ideas about sustainability.

The questionnaire used in the first phase of this project was adapted from a questionnaire used in two prior studies (Summers & Childs, 2007; Summers et al., 2004) (Appendix A). Permission to use and adapt the questionnaire was obtained (Appendix B). No information about the questionnaire's reliability and validity was mentioned by its authors. Instead it was stated that its authors had drawn upon their knowledge of the literature and used this knowledge about key issues to construct the questionnaire.

The adapted questionnaire contained the same three items as the original questionnaire:

- items designed to collect factual information, such as sex and age
- one five point Likert-type scale to self-rate understanding of sustainability
- a free response box in which to write a paragraph about their understanding of sustainability

The adapted questionnaire used in this project also contained an item relating to identification of the source(s) of knowledge about sustainability. This item was changed because the participants in this study were not the pre-service secondary teachers with specialist knowledge in either science or geography for whom the original questionnaire was designed. As the participants were student and practising primary teachers, this item was expanded to include not only formal education, but also informal education, the media, books and discussions with family/peers. Space was also provided for further comments about sources of knowledge.

The final item in the adapted questionnaire asked the participants to identify up to five issues around sustainability. This item was included to explore if teacher participants were able to link their understanding of sustainability, which is an abstract concept, with real life issues. I thought that being able to make such a link could give a further indication of their understanding. This item was not in the original questionnaire.

The types of data generated were data about the teacher participants' understandings of sustainability, their self-rating of their understanding of sustainability, sources used to learn about sustainability and knowledge of sustainability issues. Using the same questionnaire at the end of the workshops enabled me to make comparisons between teacher participants' initial and post-workshop responses.

4.6.2 Workshops

I designed a series of professional development workshops for this research project. The activities in the workshops were underpinned by Mezirow's transformative learning theory (1990 & 2003). Table 6.1 (p. 110) indicates the links between each activity and the intended targeted elements of transformative learning theory. The sequence and a description of each activity now follows.

The series of three workshops was held on five separate occasions, each over a three week period a week apart. In the first workshop, the opening activity was a picture sorting card activity (Appendix C). Every teacher participant was given 14 cards and asked to sort the cards into groups that showed instances or non-instances of sustainability. They then used a voice recorder to capture their talk as they justified their decisions. Next I gave a presentation about sustainability that included the definition of sustainability developed for this project (Appendix D). Following my presentation, the teacher participants had the opportunity to re-group their picture sorting cards. They were asked to use their voice recorder again to justify their changes or lack of them. At this point, the teacher participants had the opportunity to walk around and look at others'

groupings and discuss their reasons for placement. The last activity in the first of the workshops was the sustainability jigsaw (Appendix E). Teacher participants worked in groups of three or four to assemble the jigsaw and they were encouraged to discuss the way that it could represent sustainability. To conclude the workshop, teacher participants had the opportunity to record their thoughts about the jigsaw and the first of the workshops on the voice recorders.

The second of the workshops began with a consequence wheel activity that was set in the context of setting up a waste reduction system in a school (Appendices F and G). This was followed by a diamond ranking activity that used nine picture cards depicting a range of sustainable and non-sustainable instances (Appendix H). This activity required teacher participants to rank the picture cards with the one card showing the most sustainable instance at the top, the one card showing the least sustainable instance at the bottom and the remainder of the cards placed in order of ranking in a diamond shape. Teacher participants recorded their reasons for the placement of the cards before sharing their opinions with others. To conclude the second workshop, they were given a media article (Appendix I) and were asked to identify examples of the three components of sustainability, namely environmental, social and economic or combinations of the three within the article using differently coloured highlighter pens.

Peer interviews were conducted during the final workshop. Teacher participants interviewed each other using question guidelines supplied by me (Appendix J). I also encouraged them to ask prompting and probing questions of each other if they thought that their peer's response needed more details. After that, they re-answered the original questionnaire (Appendix A). To conclude the workshops, teacher participants were asked to find a media article that they thought illustrated their understanding of sustainability. Their chosen article was the final data generation activity as it was used in their individual interview with me. I conducted an interview asking questions about their article and their sustainable practices in their personal lives (Appendix K). This interview concluded the workshops.

The data generated and used in this project were the peer interviews and post-workshop individual interviews which will be described fully in the next sub-section.

4.6.3 Interviews

Semi-structured interviews were conducted with each group of participants. I chose to carry out interviews because they are regarded as one of the most effective ways of understanding other people's ideas (Punch, 1998). Their use enabled me to "enter the other person's perspective" (Merriam, 1998, p. 71), a significant advantage because a person's ideas, thoughts and intentions are not directly observable.

I chose to use a semi-structured type of interview because of its flexibility (Merriam, 1998). This type allowed the use of a mix of open-ended and closed questions so that I could gain an understanding of the participants' ideas about sustainability, the effects of the workshops and their teaching (Sarantakos, 2005). Semi-structured interviews also gave the participants freedom to

express their ideas. In addition, this format enabled me to probe the participants' responses to encourage them to expand on their ideas or to assist them to answer a question, which resulted in a more open discussion about their ideas (Sarantakos).

4.6.3.1 Interviews related to the workshops

Two separate interviews were conducted with the teacher participants. The first interview was a peer interview that took place during the last workshop in the series. The teacher participants interviewed each other about the workshops using an interview protocol (Appendix J) and the entire event was audiotaped. The data generated from these interviews included the teacher participants' ideas about their reasons for their participation; the most important concept/idea they learnt; the most effective activity for developing their ideas about sustainability and why; and impacts on their future pedagogy.

At the conclusion of the workshops, I interviewed each teacher participant individually and audiotaped the whole interview. Before the teacher participants came to this interview, they were asked to find a media article that illustrated their understanding of sustainability. When they were interviewed, teacher participants were asked how their article illustrated their understanding of sustainability in terms of the three components of sustainability: environmental, social and economic and its value as a teaching resource (Appendix K). This part of the interview can be regarded as an "interview-about-instances" type interview (Osborne & Freyberg, 1985, p. 6), where the concept associated with a label, in this instance sustainability, is explored. The data generated also included information about sustainable practices in their personal life and whether they had made any changes to these as a result of the workshops.

4.6.3.2 Interviews with practising teachers regarding teaching

A semi-structured format was used to interview the practising teachers about their teaching of their EfS programmes (Appendix L). These interviews were conducted after the workshops had concluded and over the course of Hamish and Mike's teaching of their EfS programmes. I interviewed Hamish three times and Mike five times in their classrooms after school had finished. The entire interviews were audiotaped. I tried to use prompts and probes to create more of a conversation than an interview situation so that Hamish and Mike would relax and share their ideas and feelings about their teaching. The data generated during these interviews included Hamish and Mike's reasons for choice of topics; information about their teaching of the concept of sustainability and how they had introduced it, taught it and the children's responses; the types of learning experiences taught; how the children had responded to the experiences; what aspects of their teaching had gone well/not so well and why; and what they intended to do next.

After their teaching of the EfS programme had concluded, I interviewed them again but this time in relation to their identity as EfS teachers (Appendix M). These interviews were also audiotaped in their classrooms after school had finished for the day. This interview was more structured than the previous interviews about their teaching because I wanted more specific information. The

data generated included how they saw themselves as teachers; how they negotiated the curriculum; their agency in professional development; their use of collegial discussions and reflection, as well as their ideas about the teaching of sustainability.

4.6.3.3 Interviews with children

Individual semi-structured interviews were conducted with the children in Hamish and Mike's classes who had returned signed parental consent forms (Appendix Z). These interviews took place during their school day in a withdrawal room and the whole interview was audiotaped. Firstly I was introduced by Hamish and Mike. I began the interview by introducing myself and explaining the purpose of the interview in order to build some rapport with the child. Before beginning the interview, I showed each child the tape recorder and discussed how they could have it turned off at any time and leave. Then I gave each child from Hamish's class a set of cards showing the three different types of bees (Appendix O) and each child in Mike's class a set of cards showing the life cycles of a plant and a monarch butterfly to put in order (Appendix P). I was not interested in whether the child could identify the types of bees or place the life cycle cards in the correct order because their teachers had already done similar tasks in their classrooms. The cards were used to gain some rapport with each child and to initiate a conversation so that I could ask questions about the bees or the life cycles. I asked the children questions to find out what they knew about the interrelationships between bees, people and plants or else the implications of a life cycle stage, for example the caterpillar, disappearing. Each child was also asked if they remembered their teacher talking about sustainability and what did this word mean. Finally they were asked if they could give an example of sustainability (Appendix N).

4.6.4 Documentary data

The third method of data generation was the collection of written material from two sources, namely the practising teachers and Hamish's class of children. These documents provided a rich data source and also became a form of triangulation when used together with other data sources (Punch, 1998).

The documentary data generated from the teachers were their planning for their EfS programmes (Appendices Q and R). I gathered the planning documents because I wanted to look for evidence of Hamish and Mike's knowledge of the presence of sustainability in *The New Zealand Curriculum* (MoE, 2007). Also, I wanted to find out if there was any evidence of their understandings of sustainability that could be linked back to their expressed understandings. In addition, I looked for evidence of their intention to teach about sustainability.

The second documentary data source provided me with text data that was written in the children's language. These documents gave me insights into Hamish's classroom children's understandings of sustainability and the data provided were able to be compared with the children's interview data (Table 7.2 p. 159). At the end of Hamish's EfS programme, the children completed a summative task that required them to answer a question about sustainability:

If the beekeeper took too much honey, what would happen to the plants? What would happen to people? What would happen to the bees? (Hamish)

Their responses to these questions were collected for analysis. Mike's class of children did not complete a written summative task.

4.6.5 Sources of data

This section concludes with a table that gives a summary of the sources of data. In this table the date of the data gathering period is indicated along with the research focus. The research activities are described and data generation methods are recorded.

Table 4.3 Timeline of data generation methods

Time Frame	Focus of Research	Description of Research	Data Generation
2008 June – December	Research questions 1 and 2	**Phase 1** Questionnaire administered to student teachers (*n*=77)	Initial questionnaire
		A series of workshops were held on four separate occasions	Peer interviews Post questionnaire
		Interviewed student teachers at end of workshops (*n*=21)	Individual interviews
2010 January	Research questions 1 and 2	**Phase 2** Questionnaire administered to practising teachers (*n*=7)	Initial questionnaire
		One series of workshops held	Peer interviews Post questionnaire
		Interviewed practising teachers at end of workshops	Individual interviews
2010 March – August	Research questions 3, 4 and 5	**Phase 3** Collected Mike's planning for EfS teaching	Planning document
		Interviews with Mike about his EfS teaching	Individual interviews
		Interviews with Mike's class of children (*n*=7)	Individual interviews
		Interview with Mike about his identity as an EfS teacher	Individual interview
2010 September – November	Research questions 3, 4 and 5	**Phase 3** Collected Hamish's planning for EfS teaching	Planning document
		Interviews with Hamish about his EfS teaching	Individual interviews
		Interviews with Hamish's class of children (*n*=11) and copied their summative tasks (*n*=7)	Individual interviews Children's written work
		Interview with Hamish about his identity as an EfS teacher	Individual interview

4.7 Analysis of Data

Thematic analysis was used to analyse the data. This type of analysis is a method for "identifying, analysing and reporting" themes within data (Braun & Clarke, 2006, p. 79). While thematic analysis is a method of data analysis that underpins many qualitative studies, it is not a method recognised in its own right like, for example, narrative analysis. Braun and Clarke argue that this situation has arisen because while many researchers allude to analysing their data by searching for common themes, in other words thematic analysis, they fail to make their decisions and assumptions overt to the reader. This failure to inform the reader of the decisions and assumptions that guided their analysis then makes it difficult to evaluate, compare or synthesise such research, which in turn can hinder further research. Therefore, when carrying out thematic analysis, it is important to acknowledge your theoretical position in relation to your research and to make the decisions and assumptions underlying your data analysis transparent for the reader.

I chose to use thematic analysis because it is able to illustrate reality and at the same time, "unpick or unravel" its surface (Braun & Clarke, 2006, p. 81) which could enable readers to understand the ways in which these participants developed an understanding of sustainability, translated it into pedagogy and its effects on their identities. It is suitable to use in research based on a constructionist ontology because it is a method that can analyse the ways that realities and experiences, such as participating in the workshops and teaching in a classroom, are affected by societal and cultural processes. In addition, it can be used to turn qualitative data into quantitative data as I have done when analysing the responses to the questionnaire.

When analysing the data set in this project, I followed Braun and Clarke's (2006) six phase guide. However, it was not a linear process but recursive because I moved back and forth between the phases throughout the process. In the first phase, I familiarised myself with the data and began to generate initial themes, in other words, organising the data into significant groupings (phase two). Phase three involved examining these initial themes for potential categories, looking for connections between themes, categories and between the categories themselves. In the next phase I worked on refining these categories. Firstly I re-read data to ensure that the data related to each category was coherent. Then I checked that the categories were representative of the entire data set. Braun and Clarke suggest that thematic maps that depict analysis can be developed at this point. Figure 6.1 (p. 111) showing reasons for participation in the workshops is an example of a thematic map that was developed during the theming process. The penultimate phase is refining and defining each category, or what Braun and Clarke refer to as capturing the "essence" (p. 92) of each category. In this phase I checked my categories to ensure that they were organised coherently and consistently and that the narrative to describe and support each category was not just a paraphrasing of the data. In addition, in this phase I had developed a clear picture of what a category was, and what it was not. Phase six was the final analysis and writing of this thesis and here I needed to ensure that the narrative told a 'story' about the categories.

There was a variety of data to be analysed: initial and post-workshop questionnaires, peer interviews, individual interviews with teachers and children, and documentary data in the form of teachers' planning, and children's work. A brief description of the analysis of each of these data sets will now be given in turn. A fuller description of my decisions and assumptions during the data analysis process is given in the three findings chapters, Chapters 5, 6 and 7 for ease of understanding.

4.7.1 Analysis of questionnaires

The questionnaire (Appendix A) was a mixture of open-ended questions and a self-rating scale with five categories ranging from *None* to *Very Good*. The data from the open-ended questions in relation to the teacher participants' definitions of sustainability, instances of learning about sustainability and sustainability issues were analysed thematically using Braun and Clarke's (2006) six phases described in the previous section. Following identification of themes, categories were developed and therefore, these data were analysed inductively (see Chapter 5).

The responses from the Likert-like scale where teacher participants self-rated their understandings of sustainability were counted. However, when I compared the teacher participants' self-ratings with their definitions, I found that I did not agree with some of their self-ratings of their definitions. Therefore, I developed two data analysis tools to analyse the level of their understanding, entitled the 'researcher's rating scale' (Figure 5.2 p. 92) and a tool to analyse the content of a definition of sustainability, entitled the 'definition content analysis tool' (Figure 5.3 p. 93).

The 'researcher's rating scale' was developed inductively based on my understanding of sustainability and interpretation of the importance (or lack of) of categories. This tool enabled me to assign a rating to a teacher participant's definition of sustainability based on the level of its content. Using this tool allowed me to measure change in teacher participants' definitions because I could analyse the definition's content level.

In order to decide on the level of content in a definition, I developed another tool, the 'definition content analysis tool'. This tool was developed deductively based on my definition of sustainability outlined in Chapter 2 (p. 24). It is a two-dimensional, five column, three row matrix that allows for analysis of the three components of sustainability: environmental, social and economic; interrelationships between these three components and the temporal component. It also allowed me to analyse the level of understanding demonstrated of each component. Depending upon the number of components and level of understanding, I was able to determine the placement of the participant's definition on the 'researcher's rating scale'.

In order to check the consistency and rigour of this tool, I gave the tool and five definitions to a colleague to code (p. 93). When their coding was checked with mine, it was the same, giving me an indication of this tool's consistency and rigour. Braun and Clarke (2008) assert that consistency and rigour are important in thematic analysis. The use of these tools meant that I

was able to analyse data consistently and rigorously because I had a tool to analyse each definition and a scale with criteria in which to place the analysed definition.

Finally, because thematic analysis allows qualitative data to be turned in quantitative (Braun & Clarke, 2006), I was able to use the Wilcoxon Signed Ranks Test to find out if there was a statistically significant difference between the student teachers' self-rating of their understandings of sustainability and my ratings of their understandings using the two tools.

4.7.2 Analysis of interview data

The data from the peer interviews, individual post-workshop interviews and the interviews with the teachers about their teaching and their identity were thematically analysed using Braun and Clarke's (2006) phases. When I was analysing the peer interviews and post-workshop interviews, a colleague offered to work alongside me, in order to peer check the themes and reduce the possibility of my biases influencing the theming. Firstly my colleague and I searched the transcripts to identify themes in the data. Once these had been established, possible categories for the themes were discussed, a consensus reached and the categories established. Next my colleague and I revisited the data, re-coded the data into themes and then placed the themes into the established categories, discussing and resolving any differences.

At this point, another tool was developed to characterise the teacher participants' identities as EfS teachers. This tool was entitled the identity characterisation tool (Table 6.6 p. 136). This tool contained criteria for four categories of teacher identity related to EfS teaching and allowed me to develop for readers a snapshot of these teacher participants' identities. The criteria for each category were based on my ideas and interpretation of the data gathered but my decisions for including these criteria were based on my knowledge of identity theory and theory related to the relationship between environmental knowledge and action. Therefore, this tool was deductively developed. As mentioned above, this third tool enabled me to analyse the data related to identity consistently and rigorously because I had a set of criteria to follow and did not have to rely on personal judgements that might have altered with time.

4.7.3 Analysis of children's interviews and documents

When analysing the data from the children's interviews, I could not use my 'definition content analysis tool' because Hamish and Mike did not teach about the three components of sustainability in their teaching. Instead I looked for evidence that these children could express a definition of sustainability similar to the one used by Hamish and Mike in their teaching. When analysing Hamish's class of children's interviews, I looked for evidence that they could identify an interrelationship between two organisms, for example bees needing plants or people needing bees; or identify an interrelationship between three organisms, namely the bees, plants and people. In Mike's classroom children's data, I looked for evidence of being able to explain consequences of an interruption to the life cycle of a plant or monarch butterfly. Finally I looked for evidence of the ability to give an example of sustainability in all of these children's data.

In addition to the interview data, I was given access to the charts that Hamish's class of children had constructed as the summative assessment task. Of the 11 children, eight of their charts provided an answer to the last question posed which related to sustainability. This question stated: If the bee keeper took too much honey, what would happen to the plants? What would happen to people? What would happen to the bees? I analysed these charts in the same way as I analysed their interview data.

4.8 Trustworthiness

Consideration of the validity and reliability of one's findings is an important part of carrying out research. In qualitative research, such as this study, I was the instrument for data generating and therefore, the findings are the result of my interpretations of the participants' reality that I accessed through interviewing, as well as analysing questionnaires and documents. Therefore, Merriam (1998) and Lincoln and Guba (1985) argue that the criteria for assessing a qualitative study are different from those used in a positivist study that aims to discover a fixed objective or phenomenon and can be encapsulated by the term 'trustworthiness'. The trustworthiness of a study can be assessed through the consideration of four aspects: credibility, transferability, dependability and confirmability (Lincoln & Guba). These aspects will now be discussed.

4.8.1 Credibility

Credibility, or its positivist equivalent of internal validity, refers to the extent to which the findings and interpretations of the study are believable and convincing (Lincoln & Guba, 1985). It also encompasses the extent to which the findings both reflect and represent the reality that has been studied (Punch, 1998). Merriam (1998) indicates that there are six strategies which researchers can use to enhance the credibility of their research. I have used three of these.

Firstly I used triangulation of data, a credibility-enhancing strategy also recommended by Lincoln and Guba (1985). Triangulation is a term that refers to a process where a researcher uses multiple data sources in order to clarify meaning and to verify the replicability of the researcher's interpretation (Stake, 2000). In this way, the researcher can illuminate meaning by showing the different ways in which the phenomenon being studied is being viewed. I used a form of triangulation in my study by using three data sources to gather the teacher participants' understandings of sustainability. Data were gathered from questionnaires, peer and individual interviews. In addition, I had two data sets about the practising teachers' translation of sustainability into their pedagogy, namely individual interviews and their planning documents. Furthermore, for Hamish's class of children I had two data sets, their individual interviews and their written task.

Peer examination is another strategy for enhancing credibility (Merriam, 1998). This strategy involves asking one's colleagues to comment on analysis and findings. I used peer examination to enhance the credibility of my study by having a colleague work alongside me to verify coding of themes for the teacher participants' peer and individual post-workshop interviews. We were able

to discuss our interpretations of data, negotiate differences and arrive at a consensus of the themes to use. I also used peer examination to develop the 'definition content analysis tool'. By asking colleagues to test the tool using a small sample of data, I was able to check to see if their interpretations of the teacher participants' definitions were the same as mine. Because they did correspond with mine, our interpretations were more likely to be accurate representations of these teacher participants' reality.

The final strategy used was ensuring that my worldview, theoretical perspective and assumptions were clarified at the beginning of the study (Merriam, 1998). My theoretical position was outlined in Chapter 1 and at the beginning of this chapter, I ensured that the ontology and epistemology that underpinned this study were discussed. In addition, the theory and assumptions behind the project were explained in Chapters 2 and 3. Lincoln and Guba (1985) also recommend this strategy to enhance credibility of both findings and interpretation of data.

4.8.2 Transferability

Transferability, which relates to external validity, refers to the issue of generalisability, or the degree to which findings can be generalised beyond one study (Yin, 2009). Generalisability has been a major issue in case study research with its critics arguing about the impossibility of making generalisations based on a single case study (Merriam, 1998; Yin). However, the reason for choosing a case study approach is because researchers want to gain a deep understanding of a particular event or phenomenon and are not focused on what is generally true on many occasions (Merriam). Therefore, case study researchers argue that because the "general lies in the particular" (Merriam, p. 210), what is found in a particular situation can be transferred or generalised by the reader to resonate with them in a similar situation. In this way, findings are a guide, rather than predictions of people's actions. Consequently, this issue reveals a tension in case study research where the "search for particularity competes with the search for generalisability" (Stake, 2000, p. 439) and it is the researcher's responsibility to balance these two factors when presenting their findings.

In order to address the issue of generalisability, it can be reconceptualised as user/reader generalisability and as a concrete universal. In terms of user/reader generalisability, the degree to which this study's findings can be applied to different contexts is up to the person using or reading the research. Merriam (1998) notes that this is a commonly used practice in medicine and law. To facilitate this reconceptualised generalisability, I provided the reader with a rich, thick description of the teacher and child participants' understandings of sustainability, as well as the way in which understandings of sustainability were developed, translated and affected teacher participants' EfS identities. By providing such a description, a strategy recommended by Lincoln and Guba (1985) to enhance transferability, I have enabled the user/reader to make comparisons between the "fit" of their situation and this study's context.

Generalisability can also be reconceptualised as a concrete universal (Merriam, 1998). Because this study has investigated the particular, in other words the participants' understandings of

sustainability, a universal can be extracted from this particular (Merriam). It can be extracted because these findings are the result of an in-depth, detailed study which can be transferred to other situations because of the way that the "general lies in the particular" (Merriam, p. 210). For example, other teachers reading this study could develop an understanding of the particular way in which the practising teacher participants translated their understandings of sustainability into their pedagogies and then be able to transfer or generalise these particular ways into their pedagogies when teaching about sustainability. In this way, people extract universals from the particular in many ways in their everyday lives.

4.8.3 Dependability

Dependability, or the interpretivist equivalent of reliability (Lincoln & Guba, 1985), is also a problematic aspect in qualitative research in which people are seen as constructing and re-constructing multiple interpretations of reality (Sarantakos, 2005). One of the aims of qualitative researchers is to describe and explain their participants' world as they experience it and since there are multiple interpretations of reality, it is virtually impossible to take repeated measures to establish reliability in the manner in which quantitative researchers do (Merriam, 1998; Sarantakos). In addition, education studies, such as this study, are complicated and highly contextual, making reliability almost impossible to achieve (Merriam). Therefore, like transferability, reliability needs to be reconceptualised as dependability (Sarantakos). In other words, dependability in a qualitative study means ensuring that the results make sense and are consistent with the gathered data (Merriam).

I used three techniques to enhance the dependability of this project. The first technique I used was to create an audit trail (Table 4.3 p. 71), which is a description of the way I carried out this study (Lincoln & Guba, 1985; Merriam, 1998). It was created so that this study could be replicated by another researcher and included descriptions of the participants involved, data generated, how the themes and categories were developed and the decisions made by me. These details are contained in this chapter (pp. 73-5), as well as in the findings chapters, namely Chapters 5, 6 and 7.

The two other techniques used to enhance dependability were also used enhance the credibility of this project. One of these techniques was making my position clear to the reader by explaining any assumptions made. In this chapter I have also described the way in which participants were selected and given descriptions of both the participants and the contexts in which the data were gathered. The final technique used to enhance dependability was a form of triangulation by using multiple methods to gather and analyse data. Using multiple methods enabled me to cross-check my interpretations of the teacher participants' understandings of sustainability with their expressed understandings.

4.8.4 Confirmability

Confirmability is related to the positivist notion of objectivity (Lincoln & Guba, 1985). However, it is only analogous to objectivity because by framing my study within a constructivist epistemology, objectivity is impossible (Sarantakos, 2005). The reason for its impossibility is that there can be no objective reality because of the way that people construct their own reality through their interpretations of their experiences. Therefore, in qualitative research, confirmability refers to the degree to which findings and interpretations can be corroborated by others (Trochim, 2006). Lincoln and Guba suggest three techniques for establishing confirmability and I have used one of these. The technique used was triangulation which was also used to enhance the credibility and dependability of my study.

Finally, Lincoln and Guba (1985) make mention of establishing confirmability through the use of an independent "inquiry audit" (Lincoln & Guba, p. 319). Although such an audit has not taken place, the records have been kept for such an event. These records include an audit trail, which was also used to enhance the dependability of this study; raw data; notes on decisions and assumptions made about theming, interpretation and the analysis process, as well as information about the development of the three data analysis tools. An independent auditor would then be able to trace the steps taken by me during this study and make an assessment of its confirmability.

In summary, through the use of these strategies, techniques and reconceptualisations, I was able to enhance the credibility, transferability, dependability and confirmability of this project, resulting in trustworthy findings that a reader could transfer and generalise to similar situations.

4.9 Ethical considerations

Ethical approval for this project was obtained for each phase of the research design. Approval for the first phase was obtained from The University of Auckland Human Participants Ethics Committee on 18 February 2008 and for the second and third phases on 10 February 2010. These approvals covered the ethical principles of informed consent, anonymity and confidentiality as well as power relationships.

4.9.1 Informed consent

Before approaching the student teachers, site access was obtained from the Faculty Dean (Appendix S). Permission to approach the student teachers was also obtained from the departmental head and course co-ordinator of a course in which these student teachers were enrolled.

Next a colleague approached the cohort of student teachers at the conclusion of a lecture to invite them to complete the anonymous questionnaire (Appendix A). An information sheet outlining the aims of the research and their rights to withdraw their questionnaire at any time up to the data analysis stage was supplied with the questionnaire (Appendix T). Completion of the questionnaire was regarded as consent to take part.

Before participating in the workshops, each student teacher was provided with an information sheet about the workshops, containing a request to sign the consent form, their right to turn off tape recorders if desired and to withdraw their data at any time up to the final data analysis (Appendix U).

Phase two of the project involved obtaining site access from the Principal and Board of Trustees of Seaview School so that the researcher could approach the practising teachers to invite them to complete the questionnaire and take part in the workshops. Once site access had been granted, the teachers were given the questionnaire and an information sheet about it. Once the questionnaire was completed, the teachers were invited to take part in the workshops. After they had indicated their interest, another information sheet containing a request to sign the consent form was provided (Appendix V).

Site access from Seaview's Principal and Board of Trustees was sought again for the final phase of the project (Appendix W). Teachers were then approached and invited to take part in a series of interviews about their translation of their understanding of sustainability into their pedagogy. A further information sheet was provided with a request to sign the consent form, together with their rights to turn off the tape recorder at any time and to withdraw their data up to the final data analysis (Appendix X).

In order to gather data from the practising teachers' classroom children, their parents/guardians were given an information sheet and a consent form to sign (Appendices Y and Z). The children returned the signed consent forms to their teachers and the teachers gave them to the researcher. Before the interviews took place, the practising teachers introduced the researcher to the children, explained about the interview, and invited those children whose parents/guardians had returned a consent form to give their assent to the interview by signing an assent form (Appendices AA and AB).

4.9.2 Participant anonymity and confidentiality

No teacher or child participants' names have been used in this research report. Although the questionnaire was anonymous, the student teachers were asked to develop a code that could be used by them to identify their questionnaire in the event that they decided to participate in the workshops. The code consisted of the initial of their first name, the day and month of their birthday and whether they were male or female. The student teachers who did participate in the workshops were all given pseudonyms by me to protect their anonymity. I chose flower names as pseudonyms in keeping with the environmental theme of this project. In order to maintain the only male's anonymity, he was given a female flower name as a pseudonym as well.

There was the issue of maintaining anonymity of the school, the teachers and the children because this project focused on one school. To maintain anonymity of the school, a pseudonym was used and it was only described in general terms. The two practising teachers chose the pseudonyms of 'Hamish' and 'Mike' to safeguard their anonymity. To protect the anonymity of the

children, each child was assigned a code that was used on their interview transcripts and documents.

In addition, the data was transcribed by a university approved transcriber who signed a confidentiality agreement. The participants were informed of this arrangement in the information sheets (e.g. Appendix X).

4.9.3 Power relationships

There were issues of differential in power relationships in this research project. In my position at the faculty, I held a position of power over the student teachers. In order to ensure that the student teachers did not feel coerced to participate, I gave an undertaking not to lecture in any of the courses being offered to that cohort in the year that the research took place. In addition, one of my colleagues approached the student teachers to tell them about the proposed research and to invite them to take part in the research. Interest in participation was indicated by them emailing my colleague or contacting me directly.

There was also the potential for a conflict of interest with the practising teachers. The Principal agreed for this research to take part in the school and so some teachers might have felt obligated to take part. An assurance was sought from the Principal and Board of Trustees in the consent form that a teacher's decision to take part or not would have no effect on their employment status. This assurance was also included in the teacher's information sheet (Appendices U and X).

The children in this project were under the age of sixteen and so required parental permission to participate. An information sheet and consent form were given to parents so that they could guide their child's decision (Appendices Y and Z). It was important that these children were given the opportunity to choose whether to participate or not because some of the data was gathered from them. Also, the school setting is problematic because attending school is compulsory, making it a "coercive situation" resulting in the child either being disempowered (Snook, 1998, p. 8) or else feeling compelled to participate (Te One, 2010). In order to counter any potential disempowerment, these children were viewed as participants and not as subjects or objects of research (Hedges, 2001). Consequently, by treating children as participants with rights, they became empowered and autonomous and their participation could then add to the truthfulness of the data giving the research project more trustworthiness.

However, the children's agreement to participate needed to be gained at the children's level of comprehension and in a form and manner that the children understood (Hedges, 2001). Therefore, in order to gain informed assent from these children, an information sheet and assent form were prepared for them using age-appropriate language (Appendices AA and AB).

4.10 Chapter summary

In this chapter I have outlined the research design used in the project. I have argued that a qualitative, interpretivist framework was best suited for exploring the research questions. Using a

case study approach was justified because it enabled me to gather a 'thick description' of the teacher and child participants' understandings of sustainability; the way in which the practising teachers translated their understanding and its effects on their identities as EfS teachers. My use of purposive sampling was discussed, the people involved in this project were introduced and the ways in which I gathered data were described.

Thematic analysis was used to analyse the data sets. The use of Braun and Clarke's (2006) six phases of thematic analysis was described along with the development of three analysis tools. Two of these tools enabled me to analyse the content and level of the participants' understandings of sustainability and measure change in their understandings. The other tool allowed me to assign each teacher participant to a category of identity as an EfS teacher.

The techniques and reconceptualisations used to enhance the trustworthiness of this project were outlined and consideration of ethical issues addressed.

The next chapter, Chapter 5, will describe the student teachers' initial understandings of sustainability. The construction of two of the tools developed for analysing the teacher participants' understandings and awareness of the concept of sustainability is also discussed. Chapter 6 explores how the student teachers' understandings of sustainability changed as a result of their participation in the workshops. The effects of the workshops on their emerging identities as EfS teachers are presented. The way in which the third tool was constructed and used is also described. The practising teachers' understandings of sustainability and the effects of the workshops on their understandings are discussed in Chapter 7. The way in which they translated their understandings into their pedagogies and its effects on their children's understandings of sustainability is also addressed. Finally, the effects of the practising teachers' understandings of sustainability on their identities as EfS teachers are discussed.

In the findings chapters the following codes will be used. Each student teacher's questionnaire was numbered. The student teachers who participated in the workshops were given flower names as pseudonyms. The two practising teachers chose their own pseudonyms of 'Hamish' and 'Mike'. The children were assigned a code consisting of letters and numbers and the school was also given a pseudonym. Significant words or phrases in the participants' quotes have been underlined.

In Chapters 1 and 4 I consciously positioned myself in this research project by using 'I' and 'me'. In the following chapters about the findings, I will use the third person to signal the way that I took a step back in order to analyse the data.

Chapter 5: An Analysis of Student Teachers' Understandings of Sustainability and Development of Tools

5.1 Introduction

This chapter presents the analysis of primary student teachers' understandings of the concept of sustainability – the first of the research questions in this project. Data were gathered using an anonymous questionnaire (Appendix A) that was administered to the student teachers at the conclusion of a lecture unrelated to the concept of sustainability. The questionnaire contained a mixture of open and closed questions, as well as a self-rating of understanding scale with five categories that ranged from *None* to *Very Good*.

As discussed in Chapter 2, the concept of sustainability is both contested and complex (Corney & Reid, 2007). While there is agreement that sustainability is comprised of three components: the environment, society and the economy (Gough, 2002), there are problems associated with its definition. These problems are its evolving nature; its ambiguity and value-laden nature; its abstraction, the need for contextualisation and inclusion of a temporal component. There is also the issue of the incorporation of resilience theory. Therefore, the researcher developed a theoretical definition of sustainability for this project which states:

> Sustainability is made up of three interrelated components: environmental, social and economic. These components interact in ways that are unpredictable and co-evolutionary that effect further environmental change with unforeseen outcomes. Sustainability is a dynamic process when working to resolve an environmental issue, but not the end point.

This theoretical definition is represented diagrammatically in Figure 5.1 as:

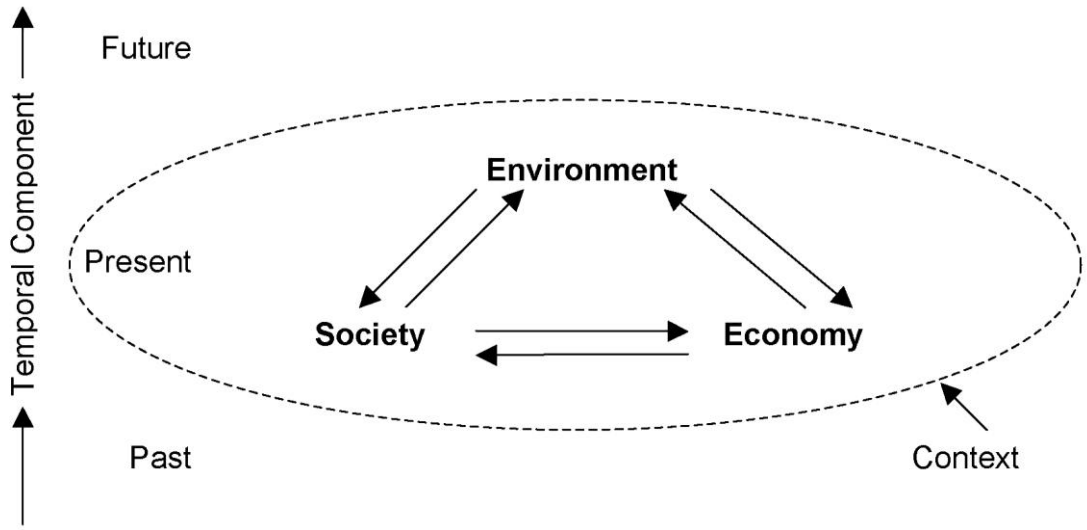


Figure 5.1 Researcher's theoretical definition of sustainability

The data from the questionnaires were analysed using thematic analysis (Braun & Clarke, 2006) and the definition provided above was used to develop data analysis tools which will be described in this chapter.

5.1.1 Chapter structure

The student teachers' understandings of sustainability are presented in Section 5.2 where examples and justification of each category are given. In Section 5.3 the student teachers' self-rating of their understanding of sustainability is discussed and their ratings compared with the researcher's ratings based on analysis of their definitions. How the researcher developed these ratings using two data analysis tools is also discussed. Sustainability issues that student teachers have identified in the questionnaire are presented in Section 5.4. This chapter finishes by presenting the data about where and/or when the student teachers indicated they learnt about the concept of sustainability in Section 5.5.

5.2 Student teachers' understandings of sustainability

Seventy-seven student teachers in the first semester of their third year of a Bachelor of Education (Tchg) primary specialisation completed the anonymous questionnaire. It was administered at the end of a lecture in a course unrelated to education for sustainability. The degree has no compulsory course about sustainability although there is an optional environmental education course available. Because this optional course is only taken in the last semester of the degree, no formal degree-level pre-teaching of sustainability had occurred at the time of the questionnaire's administration.

One of the questionnaire's open ended questions asked the student teachers to write a definition of the concept of sustainability. Ten different categories were developed during thematic analysis of the data (Braun & Clarke, 2006). These categories were developed inductively as their development was "data driven" (Braun & Clarke, p. 83). In order to establish the categories for the data, the researcher first searched the questionnaire responses to identify themes in the data. Here she was looking for words or phrases that the student teachers had used that were similar. Once the themes had been identified, possible categories for the themes were established. Then, when the categories had been established, the researcher revisited the data, re-coded the data into themes and then placed the themes into established categories. It is important to note that no hierarchy of categories was made at this point. The categories were *Resources*; *Caring for the Environment; Lifestyle Choices; Economics; Interrelationship of Components; Future Planning; Intergenerational Equity, Unqualified/Uncontextualised; Unrelated Ideas* and *No Response Given* and these categories are shown in Table 5.1.

The themes were words or ideas that indicated a response that would be placed in a particular category. In the *Resources* category, the word 'resources' and their use was a theme as was mention of specific resources such as oil, food and water. Recycling and waste were also themes. Themes for the *Caring for the Environment* category included words like preserving,

conserving, looking after or protecting the environment. Reducing impacts on it was another theme. The *Lifestyle Choices* category included themes such as making choices or decisions that impact on the environment or planet. Themes placed in the *Economics* category included reference to economic growth. To be placed in the *Interrelationship of Components* category, mention had to be made of the three sustainability components of environment, society and the economy. The *Future Planning* category contained themes related to resources, people or the planet being able to last or survive into the future. Themes placed in the *Intergenerational Equity* category referred to looking after resources now so that there would be sufficient for future generations. The *Unqualified/Uncontextualised* category contained themes that referred to keeping something the same, sustaining or maintaining something. Themes that did not fit into any of the categories above and were unrelated to sustainability were placed in the *Unrelated Ideas* category. The final category, *No Response Given*, was created for those student teachers who did not express a definition at all.

It is important to note that some of the student teachers' definitions were placed into more than one category because they contained more than one idea, or what will be referred to as a 'conceptual indicator', about sustainability. A conceptual indicator was seen as a word or phrase that expressed a student teacher's understanding of sustainability. Altogether, a total of 94 conceptual indicators were given, resulting in multiple response data. Each of these responses was regarded as an individual conceptual indicator and placed in a category. Table 5.1 gives examples of the types of conceptual indicators that were placed in each category as well as their frequency and percentage of use. Each category is then related to components of the researcher's theoretical definition given at the beginning of this chapter.

Because some of the student teachers gave more than one conceptual indicator in their definition, this categorisation allowed for the complexity of a definition to be analysed. Nine of the student teachers provided a definition with two conceptual indicators, one gave a definition with three, and two student teachers gave a definition containing four conceptual indicators. The table in Appendix AC shows the number of conceptual indicators given by each student teacher. An example of a definition with multiple conceptual indicators was ST69 who wrote:

> *Looking after natural resources. Being aware of and making decisions in order to look after the planet. Involves taking into consideration the future. Realising we only have one planet, our decisions and lifestyles have an impact.* (ST69)

This definition contained four conceptual indicators and was coded into four separate categories. The first sentence was put in the *Resources* category because of its reference to resources. The second sentence was categorised as *Caring for the Environment* because it referred to looking after the planet and the third was placed in the *Future Planning Category* due to its reference to considering the future. The final statement was put into the *Lifestyle Choices* category since it refers to the impact that lifestyles can have on the environment.

Another example is ST32 who wrote that sustainability meant:

> *The viability of farming/producing a resource for use, takes into consideration whether the environment the resource is found in can handle the effects/spinoffs of providing/having the resource taken from it. Usually natural resources like oil, coal, etc.* (ST32)

This response contained two conceptual indicators and was placed into two categories, *Resources* and *Caring for the Environment*. The first sentence was categorised as *Resources* because it referred to the production of resources, as was the second sentence because of its reference to specific resources. The second half of the first sentence also mentioned the environmental impact of the removal of resources implying an understanding of potential degradation so it was categorised as *Caring for the Environment*. Even though there were two references that were categorised as *Resources*, it was only recorded once.

Thirty-two conceptual indicators (34%) were placed into the *Resources* category. Conceptual indicators placed into this category contained reference to resources, their use, their production or the way that resources have a limit (coloured red in the quotes). Some of the examples of conceptual indicators were simple. An example of a simple conceptual indicator that was coded as *Resources* was from ST36 who wrote that sustainability meant:

> *Resources that are used. The availability of resources.* (ST36)

This conceptual indicator was coded as *Resources* because of its reference to resource use and their availability. Some conceptual indicators showed more complexity but were still placed into the *Resources* category. ST47's definition was an example of a complex *Resources* conceptual indicator and it was stated that sustainability meant:

> *The ability to put measures into place in order to make our national resources longer lasting (replace the resources that you use).* (ST47)

This response was deemed to be more complex because not only does it refer to resources, it also indicates that sustainability is about making resources last longer, that resources are limited and can be used up. ST47's definition is also more complex because reference is made to "measures" being taken to make the resources last longer. This inclusion could be referring to debate around whether governments should pass legislation to enforce resource longevity or should this come from people's desire to conserve resources.

A further type of conceptual indicator placed into the *Resources* category was those referring to recycling. References to recycling were placed in this category because recycling is the re-using of existing resources so that resource stocks are not depleted. An example of a response that included a recycling conceptual indicator was that of ST54 who wrote that sustainability meant:

> *The lasting factor of something – reuse, recycle, refuse. Resources being used up – problem.* (ST54)

In this response ST54 refers to resources and how long they can last by recycling or re-using. She also identified that resource depletion is a problem but doesn't specify why this is a problem and for whom. Thus this response was placed in the *Resources* category.

Eleven of the student teachers' definitions (11.7%) included conceptual indicators that were categorised as *Caring for the Environment* (coloured bright green in the quotes). To be placed into this category required reference to protecting or looking after the environment. An example of a conceptual indicator that was placed into this category was ST46's definition:

> *About sustaining the environment. It is about looking after it and ensuring that it sustains/survives, i.e. global warming.* (ST46)

This response was coded into the *Caring for the Environment* category because reference is made to looking after the environment to make sure that it remains viable. By referring to the environment surviving, ST46 could hold the belief that the environment is an entity in itself, similar to Lovelock's Gaia Hypothesis (Williams, 2005). There is also an environmental issue given which could show that ST46 is aware that global warming is a threat to the survival of the biosphere.

Three conceptual indicators (3.2%) were coded into the *Lifestyle Choices* category (coloured orange in the quotes). An example of such a conceptual indicator was ST2's definition:

> *Making use of natural resources to sustain a reasonable lifestyle ….* (ST2)

This response was coded into the *Lifestyle Choices* category because it makes a link between resource use and lifestyle, implying that people need to make choices about the resources they use in their life because such choices have an impact on the environment. Her reference to a "reasonable lifestyle" could be her belief that there is a certain standard of living to which people are entitled. She could also be inferring that some people live above this standard, while others live below it and there needs to be a balancing of the two. ST2's definition was also placed in *Resources* because of its mention of using resources.

As shown in Table 5.1, these three categories relate to the environmental component of the researcher's theoretical definition of sustainability. The *Resources* category relates to this component because it encompasses ideas about resource use and the impact of such use on the environment. Conceptual indicators in the student teachers' definitions that were categorised as *Caring for the Environment* relate to the environmental component because they referred to looking after and protecting the environment. The responses that were coded into the last category, *Lifestyle Choices*, related to the environmental component because they related to people making choices in their lives that lessened their impact on the environment.

Table 5.1 Categories of definitions given by the student teachers, examples of conceptual indicators, frequency and percentage used

Researcher's Definition Components	Categories of Conceptual Indicators and Examples	Frequency *n*=94	% of Responses
Environmental Component	**Resources** "reuse, reduce, recycle – rather than making more and more stuff which gets wasted … " (ST5) "limited global resources, e.g. oil, food and how it affects the world … " (ST30) "innovation as how to reduce wastage and ways to work more efficiently (resource use) … " (ST45)	32	34.0
	Caring for Environment "doing something that doesn't impact on our environment … " (ST12) "different ways to protect the environment … " (ST19) "it's about looking after the environment and ensuring it survives e.g. global warming … " (ST46)	11	11.7
	Lifestyle Choices Category "healthy lifestyle towards environmental factors trying to decrease impact = better life … " (ST13) "realising we only have 1 planet - our decisions and lifestyles have an impact … " (ST69)	3	3.2
Economic Component	**Economics Category** "Economic growth is often seen as infinite but in reality it is impossible." (ST67)	1	1.1
Interrelationship of components	**Interrelationship of Components Category** "sustainability is a very broad umbrella term that refers to sustaining the cultural, natural, social, economic, etc. world … " (ST83)	2	2.1
Sustainability having a temporal nature	**Future Planning Category** "man's (attempt) activity to find alternative options to use our resources efficiently and effectively to achieve/last for a lifetime … " (ST17) "sustaining our natural resources to ensure continued survival of people and our earth … " (ST53)	7	7.5
	Intergenerational Equity "able to preserve resources so that there is enough to last future generations … " (ST15) "retaining natural resources so that future generations will be able to have them … " (ST29)	4	4.3
Responses unrelated to researcher's definition	**Unqualified/Uncontextualised Category** "something that can be continued … " (ST8) "ability to sustain … " (ST31) "keep something at an even level … " (ST49)	17	18.1
	Unrelated Idea Category "having a balance … being secure … experiments" (ST34) "routines … having things … knowing … " (ST61)	4	4.3
	No Response Given	13	13.8

The next category in Table 5.1 is *Economics* (coloured brown). Only one student teacher's response (1.1%) was categorised as *Economics*:

> … *economic growth is often seen as infinite but in reality it is impossible*. (ST67)

This response was categorised as *Economics* because of its reference to continual economic growth being impossible to maintain, a viewpoint expressed by green socialists such as Huckle (1991). Green socialists argue that continual economic growth is impossible because such growth relies on resources which have a limit. Also, it is argued that continual growth, with its imperative of accumulation of capital will not deliver social justice and consequently, widen the gap between the developed and developing world (Huckle).

The *Economics* category links directly to the economic component of the researcher's theoretical definition of sustainability. It links directly because it contains ideas about economic growth and activities.

The *Interrelationship of Components* is the next category in Table 5.1 (quotes are in turquoise). For a response to be coded into this category, it had to contain reference to the three components of sustainability given in the researcher's theoretical definition: the environment, society and the economy mentioned together. In this way it relates directly to the researcher's theoretical definition. Two student teachers' conceptual indicators (2.1%) were placed into this category. An example was ST83's definition:

> *Sustainability is a very broad umbrella term that refers to sustaining the cultural, natural, social, economic, etc. world. It's about using resources that can be renewed and planning for the long term, with the big picture in mind.* (ST83).

ST83's first sentence recognises that sustainability is comprised of more than an environmental component, or what she refers to as "natural". ST83 also refers to the social component and includes a cultural and economic component. This student teacher goes further when she writes about sustaining these components which could be interpreted as her awareness that all of these components are needed for our world to continue. Two other conceptual indicators in ST83's definition were placed into other categories. The second sentence was categorised as both *Resources* and *Future Planning*.

The next two categories in Table 5.1 relate to the temporal nature of sustainability that is referred to in the researcher's theoretical definition. A temporal scale recognises that knowledge is limited and the future uncertain. Thus, at a given moment in time, a society might be in a sustainable state, but circumstances can change, leading to an unsustainable state.

Conceptual indicators that reflect this idea can be seen in the *Future Planning* category (quotes are in blue). Seven student teachers' conceptual indicators (7.5%) were placed into this category and an example is ST53's definition:

Sustaining our natural resources to ensure continued survival of people and our earth. (ST53)

The second half of this response illustrates that ST53 is aware of the link between people, the Earth and resources, and if care is not taken of resources then this could impact on survival of people and also our planet. By using the word "continued", ST53 demonstrated a temporal component because she is projecting the survival of both people and the Earth into the future. The first half of ST53's definition contained a further conceptual indicator that was coded under *Resources*.

The other category that reflects the temporal nature of sustainability in Table 5.1 is *Intergenerational Equity* (quotes coloured lavender). Four student teachers' conceptual indicators (4.3%) were categorised as such. An example of this type of definition was ST29's response:

Retaining natural resources so that future generations will be able to have them. (ST29)

This response was categorised *Intergenerational Equity* because of its reference to resources being preserved for future generations and the idea that people today should be thinking about people of the future being able to have a quality of life similar to that we have today. The thinking ahead about future generations gives this type of response its temporal character, which links to the researcher's definition of sustainability. It is important to note that this response was only categorised as *Intergenerational Equity* and not in *Resources* as well because in order to be coded as *Intergenerational Equity*, reference to preserving resources needed to be made.

The remainder of the categories in Table 5.1 did not relate to the researcher's definition of sustainability. 17 of the conceptual indicators (17.0%) related to ideas about something being continued, maintained or sustained, like a dictionary-type meaning of sustainability or a common language meaning, but had no relationship with the researcher's definition. Such responses were categorised as *Unqualified/Uncontextualised* (quotes coloured blue-grey) and an example of this type of response is:

Sustainability is maintaining a state indefinitely. (ST37)

Another example of this type of response but using the word "sustained" was ST49 who wrote that sustainability meant:

Being able to sustain something. Keep something at an even level. (ST49)

Another characteristic of many of the responses coded into this category was their lack of context. The responses were general and used words such as "state", "something" or "things" rather than mentioning a specific instance, like a rainforest, as is illustrated in the previous two examples.

Four of the student teachers' conceptual indicators (4.3%) were categorised under *Unrelated Idea*. This type of response did not appear to have any relationship to the word sustainability

either in terms of the researcher's definition or a dictionary-type definition. An example of this type of response is ST33's definition:

> *Farming, building, safety, building consents.* (ST33)

Another such response was ST61's. She wrote a definition of sustainability as:

> *Routines, having things, knowing* (ST61)

The last category in Table 5.1 is *No Response* and those student teachers who left the space for defining sustainability blank were coded into this category. 13 student teachers (13.8% of responses) left the space blank.

In summary, Table 5.1 shows that the student teachers held a wide range of ideas about the concept of sustainability. This table also illustrates that nearly half of the student teachers' conceptual indicators related to the researcher's environmental component of sustainability (46 or 48.9%). Eleven conceptual indicators (11.8%) related to sustainability's temporal component. Only one conceptual indicator related to the economic component and no one mentioned the social component. However, two conceptual indicators did mention the interrelationship between these three components. This table also illustrates the difficulty of defining sustainability with 21 conceptual indicators (22.4%) being unrelated to the researcher's definition and 13 (16.9%) student teachers seemingly unable to provide a definition. The table in Appendix AC showing the numbers of conceptual indicators used also provided evidence of this difficulty. Fifty-two out of 77 student teachers (67.5%) were able to give one conceptual indicator that related to sustainability. Just 12 student teachers (15.6%) were able to give more than one conceptual indicator in their definition of sustainability.

The student teachers were also asked to rate their understanding of sustainability which is an indication of their self-awareness of sustainability and these results will be discussed in the next section.

5.3 Student teachers' ratings showing self-awareness of their understanding of sustainability

In the questionnaire these student teachers were asked to self-rate their understanding of sustainability on a five point scale labelled very good, good, reasonable, little and none. Their self-ratings were regarded by the researcher as indicative of their self-awareness of their understanding of sustainability. The researcher thought that student teachers' awareness might be significant because she could compare their self-perception with their actual understanding by judging these against her definition of sustainability. Firstly, Section 5.3.1 will describe how the researcher developed two tools that allowed her to analyse these student teachers' self-ratings of their understanding of sustainability. Section 5.3.2 provides examples for each of the rating positions in the 'researcher's rating scale' and justifies their choice. The comparison between the

student teachers' self-ratings of their understandings is then compared with the researcher's ratings in Section 5.3.3.

5.3.1 Development of two tools: 'Researcher's rating scale' and 'definition content analysis tool'

Forty-five out of the 77 student teachers self-rated their understanding as *Little* or *None,* 28 as *Reasonable*, two as *Good* and two as *Very Good*. However, when the researcher was analysing these student teachers' responses, she found that she did not agree with some of their self-ratings. Therefore, the researcher decided to develop a rating scale based on her theoretical definition and compare her ratings of their definitions with the student teachers' self-ratings.

In order to develop tools to analyse the student teachers' self-ratings and compare them with the 'researcher's rating scale', decisions had to be made by the researcher about what categories of definitions and numbers of categories illustrated each rating position. It needs to be acknowledged that the decisions made were based on the researcher's understanding of sustainability and her interpretation of the importance (or lack) of particular categories. These decisions are shown in Figure 5.2. This figure is a hierarchy of rating of understanding positions and gives examples of responses to illustrate the rating position that are coloured to indicate which category of conceptual indicator they belong (p. 85). The student teachers whose responses were placed in that rating position are also given.

The data in Figure 5.2 showed that when using the 'researcher's rating scale' and 'definition content analysis tool', 17 student teachers had an understanding rating of *None* and 16 had a rating of *Little*. Twenty-eight had a *Reasonable*-ranked rating. Eleven student teachers' definitions were rated by the researcher as *Good* and three *Very Good*. Two of the student teachers' definitions of sustainability (ST42 and ST83) were regarded by the researcher as being sophisticated and she decided to create another category for them, that of *Very Good Plus*.

Once the researcher had decided on the criteria for each rating point, a data analysis tool was used to analyse each definition before placing that student teacher's definition into a rating position. This tool entitled the 'definition content analysis tool' is shown in Figure 5.3. The tool was deductively developed using the researcher's definition of sustainability (Braun & Clarke, 2008).

It is a two-dimensional, five column, three row table that allowed the researcher to analyse each student teacher's definition for the components of sustainability, connections between the components and use of a temporal scale. Double column lines were placed between the components, connections and temporal scale columns to show that these were separate from each other. When a conceptual indicator met the criterion for the cell, a tick was placed in that cell. There was also capability for identification of the complexity of the components. The bottom rows of the tool were indicative of simple definitions rated in the *None* rating positions and the top rows indicative of the more complex ratings such as *Good* or *Very Good*. The number of ticks given was also indicative of complexity. The more ticks given, the more complex a definition was rated.

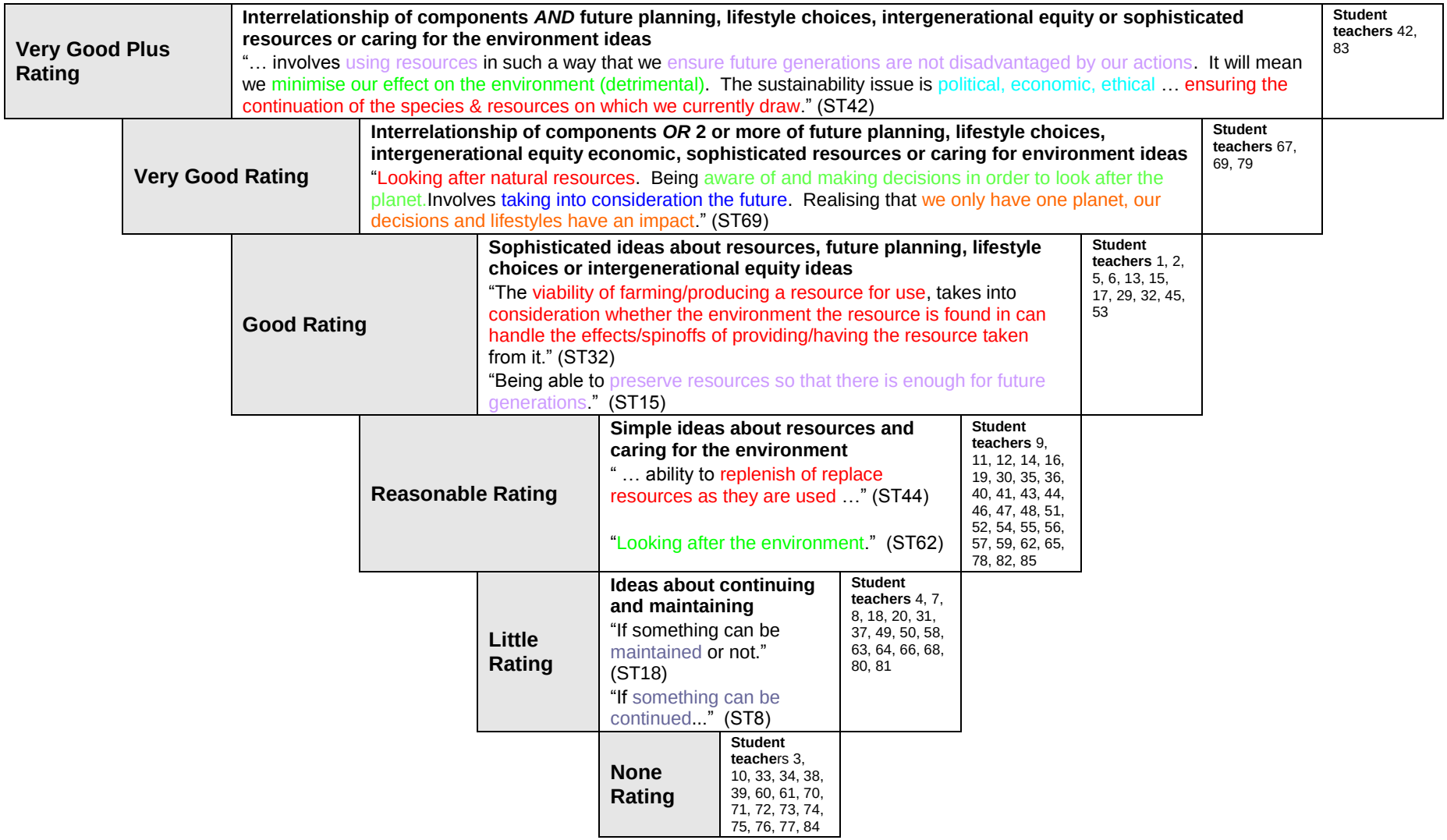


Figure 5.2 The 'researcher's rating scale', examples of definitions placed in each position and student teachers' responses placed in that position

Complex				**2**			**Specified future**
Adequate				**1**			**Unspecified future**
Simple				**0**			**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.3 'Definition content analysis tool' for identifying rating position of definitions

In order to test the tool's consistency and rigour (Braun & Clarke, 2006), a range of five definitions were given to two colleagues to code. Their coding was checked with the researcher's and found to be the same, which is an indication of the consistent and rigorous nature of this tool.

The next sub-section provides examples for each of the rating positions in the 'researcher's rating scale' and justifies their choice.

5.3.2 Examples and justification for rating positions in 'researcher's rating scale'

When using an interpretivist methodology, it is important that the decisions made by the researcher about analysis are transparent to the reader. Consequently, this transparency enhances the trustworthiness of the research (Merriam, 1998; Lincoln & Guba, 1985). Therefore, the researcher considered it important to describe the decisions she made when constructing the 'researcher's rating scale' and the 'definition content analysis tools'.

With regard to the 'researcher's rating scale' illustrated in Figure 5.2, responses that were coded into the *Unrelated Ideas* or *No Response* categories related to the *None* rating position because these responses did not show any understanding of the definition of sustainability presented in this research project. These types of definitions received two ticks, one in the Zero Connections cell and one in the None Temporal Scale cell. Since no components of sustainability were mentioned, no ticks could be placed in any of the components cells. An example of this type of response that has been analysed using the 'definition content analysis tool' is shown in Figure 5.4.

Complex				**2**			**Specified future**
Adequate				**1**			**Unspecified future**
Simple				**0**	√	√	**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.4 Example of an *Unrelated Ideas* or *No Response* definition analysis placed in the *None* rating position

The next rating position, *Little,* encompassed all of the responses in the*Unqualified/Uncontextualised* category because this type of response seemed to demonstrate an emerging understanding of sustainability. The emerging understanding was shown by the way that student teachers' responses placed into this rating category used words like maintaining, continuing or something ongoing, which is a dictionary-type definition of sustainability. An example of a maintenance-type response is ST18 who wrote:

> *If something can be maintained or not.* (ST18)

Another example where the word continuing is used is ST8's definition:

> *If something can be continued.* (ST8)

Both of these responses received one tick in the Unspecified Temporal Scale cell because continuing or maintaining something is indicative of a time scale and one in the Zero Connections cell. This type of response was considered more complex and this is reflected by having one of the ticks in the level above that of the ticks assigned to definitions rated at the *None* rating position. Since no components of sustainability or connections were mentioned, no ticks could be placed in any of those components' cells and this analysis is shown in Figure 5.5.

Complex				**2**			**Specified future**
Adequate				**1**		√	**Unspecified future**
Simple				**0**	√		**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.5 Example of *Unqualified/Uncontextualised* definition analysis placed in the *Little* rating position

The next rating position in Figure 5.2 is *Reasonable*. The *Reasonable* rating position included most of the definitions that had been categorised into the *Resources* or *Caring for the Environment* categories. These responses were regarded as *Reasonable* because they showed a naïve and simplistic understanding of sustainability in that either resource use or caring for the environment was identified as a definition with no details given. An example of a simple *Resources*-categorised response that was rated by the researcher as *Reasonable* was ST44's definition:

> *Sustainability in the environment – ability to replenish or replace resources as they are used.* (ST44)

ST62's response is a simple *Caring for the Environment*-categorised response researcher-rated as *Reasonable*:

Looking after the environment. (ST62)

When using the 'definition content analysis tool', these types of responses were given a tick in the Simple Environmental Component cell as well as ticks in the Zero Connections and None Temporal Scale cells, a total of three. These responses were rated as more complex and placed in the *Reasonable* rating position because they included one of the three components of sustainability which the researcher regarded as more complex than either identifying connections or having a temporal scale. An analysis of this type of definition is contained in Figure 5.6.

Complex				**2**			**Specified future**
Adequate				**1**			**Unspecified future**
Simple	√			**0**	√	√	**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.6 Example of a simple *Resources* or *Caring for the Environment* definition placed in the *Reasonable* rating position

The *Good* researcher-rating position required responses that could still be categorised as either *Resources* or *Caring for the Environment* but needed to be more complex in terms of content or examples. Responses that were placed in either the *Future Planning*, *Lifestyle Choices* or *Intergenerational Equity* categories were placed in this rating position too. An example of a *Resources*-categorised response is this definition of sustainability:

> *The viability of farming/producing a resource for use, takes into consideration whether the environment the resource is found in can handle the effects/spinoffs of providing/having the resource taken from it.* (ST32)

ST32's response is regarded as complex because it is not just referring to a resource, but discusses the feasibility of resource production as well as considering the impact on the environment of removing the resource. This definition was also categorised as *Caring for the Environment*. This response received three ticks in the data analysis tool, one in the Adequate Environmental Component cell for the reference to resources and effects on the environment, one in the 1 Connections cell for the connection between resources and their removal affecting the environment and one in the None Temporal Scale. The greater complexity of the response is shown in Figure 5.7 by the way that two out of three ticks were placed in the middle row of the tool.

Complex				**2**			**Specified future**
Adequate	√			**1**	√		**Unspecified future**
Simple				**0**		√	**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.7 Example of a complex *Resources* definition analysis placed in the *Good* rating position

Future Planning and *Intergenerational Equity* category definitions were also placed into the *Good* rating position. The point of difference between the *Good* researcher-rating of these types of definitions and the *Reasonable* rating category is that these definitions included ideas with a temporal nature which the researcher regarded as more complex than a definition about either using resources or protecting the environment. For example, an *Intergenerational Equity*-categorised definition was given by ST29:

> *Retaining natural resources so that future generations will be able to have them.* (ST29)

This response was given a researcher-rated understanding position of *Good* because ST29's definition included the belief that people today need to consider their use of resources so that people in the future will also have access to them. By referring to people in the future, ST29 showed her understanding of sustainability having a temporal nature. ST29's response received three ticks in the data analysis tool. One tick was placed in the Simple Environmental Component because of the mention of resources. Another tick was placed in the 1 Connections cell due to the link made between resource use and people of the future also needing resources. The last tick was placed in the Specified Temporal Scale because ST26 made reference to something specific, namely future generations. Again, this response shows a degree of complexity because of the placement of the ticks in the middle and top rows of the tool as is shown in Figure 5.8.

Complex				**2**		√	**Specified future**
Adequate				**1**	√		**Unspecified future**
Simple	√			**0**			**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.8 Example of an *Intergenerational Equity* definition analysis placed in the *Good* rating position

Lifestyle Choices definition category responses were also included in the *Good* researcher-rating position. The reason for their inclusion in this rating position was that this type of response

showed an understanding of the link between people's actions and their impact on the environment. Such an understanding was regarded by the researcher as more complex than a response which mentioned resource use or protecting the environment because it made a direct connection between actions and effects of such action on the environment. ST2's definition was an example of this type of response:

> *Making use of natural resources to sustain a reasonable lifestyle without buying unnatural resources.* (ST2)

In her response ST2 seems to show an understanding that an adequate standard of living can be achieved through the use of particular resources without having to rely on what ST2 refers to as "unnatural" resources which could possibly refer to nonrenewable resources. This response also received three ticks in the tool, but in different places. One tick was placed in the Adequate Environmental Component cell because of the mention of resources and ST2's understanding of "unnatural resources" that could be interpreted to mean that some resources need to be husbanded because they cannot be renewed, one in the 1 Connections cell due to ST2 making the link between resource use and lifestyle choices and the last tick in None Temporal Scale. The complexity of this response is illustrated in Figure 5.9 by the way that two ticks were in the middle row of the tool and a sustainability component had been identified.

Complex				**2**			**Specified future**
Adequate	√			**1**	√		**Unspecified future**
Simple				**0**		√	**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.9 Example of a *Lifestyle Choices* definition analysis that was placed in the *Good* rating position

The next researcher-rating position was *Very Good*. To be coded into this rating category, a response that was categorised as *Interrelationship of Components* or else a response that consisted of two or more aspects from the *Future Planning, Intergenerational Equity, Lifestyle Choices, Economics* or sophisticated *Resources* or *Caring for the Environment* were required. An example of this type of response was ST79's definition. It comprised of two conceptual indicators and was placed into *Future Planning* and *Intergenerational Equity*. She wrote that sustainability meant:

> *The ability to ensure that we have adequate resources, energy and food for the future as well as for now, e.g. planting forests for the use of wood now to use in the future instead of chopping down all of the nations trees & not having anything left for future generations.* (ST79)

The first conceptual indicator included in this definition was categorised as *Future Planning* because ST79 seemed to be showing an understanding of the need to think about the resources we are using today to make certain that there are enough for the future. In the second half of her response, ST79 contextualised the definition and in doing so mentioned the need to do this so that future generations have sufficient resources. This was an *Intergenerational Equity*-categorised conceptual indicator and because ST79's definition contained both of these conceptual indicators, it was placed in the *Very Good* rating position using the researcher's criteria.

ST79's response received three ticks in the 'definition content analysis tool' shown in Figure 5.10. One was placed in the Adequate Environmental Component cell because of her reference to resources being needed and examples given. A further tick was put in the 2 Connections cell because of the link made between thinking about conserving resources for future use and the link between resources being available for people in the future. The final tick was placed in the Specified Temporal Scale because ST79 specifically mentioned future generations of people. The complexity of this definition was illustrated by the way that two of the three ticks were in the top row of the tool with one in the middle row.

Complex				**2**	√	√	**Specified future**
Adequate	√			**1**			**Unspecified future**
Simple				**0**			**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.10 Example of an *Interrelationship of Components and Future Planning* definition analysis placed in the *Very Good* rating position

There were two student teachers who gave very complex definitions that combined the *Interrelationship of Components* category with at least two other conceptual indicator categories. Due to the level of sophistication, the researcher decided to create another level of rating above the *Very Good*, entitled *Very Good Plus*, so that this level of understanding could be acknowledged. However, these two student teachers' definitions were still included in the *Very Good* rating position in the results presented in Table 5.2 because the student teachers themselves only had the five point self-rating scale from which to choose. ST42's definition was rated as *Very Good Plus:*

> *Sustainability involves using resources in such a way that we ensure future generations are not disadvantaged by our actions. It will mean we minimise our effect on the environment (detrimental). The sustainability issue is political, economic, ethical. I think sustainability is about ensuring the continuation of the species & resources on which we currently draw.* (ST42)

ST42's definition was rated as *Very Good Plus* because it contains four conceptual indicators, one of which was categorised as *Interrelationship of Components*. This conceptual indicator is contained in the third sentence where mention is made that sustainability is political which relates to the social component of the researcher's definition; economic which relates to the economic component; and ethical which relates to the social component. Although no mention is made of the environmental component, ST42 also mentions that sustainability is about "ensuring the continuation of the species" in her fourth sentence, which could be indicative of the environmental component.

The first sentence in ST42's definition contains a conceptual indicator categorised as *Intergenerational Equity* because of its reference to preserving resources for use by future generations. The conceptual indicator in her second sentence was categorised as *Caring for the Environment* because she referred to minimising people's detrimental effect on the environment. The final conceptual indicator in ST42's fourth sentence was placed in *Resources* but can be regarded as a sophisticated *Resources* conceptual indicator because ST42 discusses the need to make certain that people continue to have access to resources that they currently use and mention is also made of ensuring continuation of species. Whether ST42 is referring to species of flora or fauna is uncertain but mention of species could imply an eco-centric attitude towards other forms of life, rather than an anthropocentric attitude, making this response a more complex one.

ST42's definition received five ticks and is shown in Figure 5.11. One tick was placed in the Complex Environmental Component cell because reference made to ensuring a supply of resources for people, continuation of "species" and also minimising detrimental environmental impacts. A tick was placed in both the Simple Economic and Simple Society Component cells due to mention of sustainability being economic, political and ethical and no explanations given about these components. Another tick was placed in the 2 Connections cell because of the link between people in the future having sufficient resources and people today being aware that enough resources are left. A further link was made between people's actions and their ability to minimise their negative effects on the environment. Finally, a tick was placed in the Specified Temporal Scale because ST42 mentioned future generations. The large number of ticks and having three placed in the top row of the tool showed the complexity of this definition.

Complex	√			**2**	√	√	**Specified future**
Adequate				**1**			**Unspecified future**
Simple		√	√	**0**			**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 5.11 Example of an *Interrelationship of Components, Intergenerational Equity, Caring for the Environment* and *Resources* definition placed in the *Very Good Plus* rating position

A comparison between the student teachers' self-ratings and the researcher's rating of their understandings will now be discussed.

5.3.3 Comparison between student teachers' self-ratings and researcher's ratings

As discussed at the beginning of this section (p. 91), during analysis the researcher noticed that some of the student teachers' self-ratings of their understanding did not match her rating of their understanding. A comparison was then made between the student teachers' self-ratings and the researcher's rating of their definitions to explore the degree of correspondence between the two. This comparison data is presented in Table 5.2.

Table 5.2 Comparison between the student teachers' self-rating and the researcher's rating of their understandings

Rating Category	Self-Rating		Researcher's Rating	
	Frequency *n*=77	% of Responses	Frequency *n*=77	% of Responses
None	12	15.6	17	22.1
Little	33	42.9	16	20.8
Reasonable	28	36.4	28	36.4
Good	2	2.6	11	14.3
Very Good	2	2.6	5*	6.4*

Note. * includes the two student teachers with a rating of *Very Good Plus*

Table 5.2 shows the similarities and differences between the student teachers' self-rating of their understandings and the researcher's rating of their understandings. Firstly, when comparing the self-rating and researcher's rating positions, there is the same number of responses in the *Reasonable* category each time. There is also a similar number in the *Very Good* category, two with the self-rating and five with the researcher's rating, bearing in mind that the researcher regarded two of the responses in the researcher's *Very Good* rating to be *Very Good Plus*.

In terms of differences between the two different ratings, there are far more student teacher self-ratings in the *Little* category (33 or 42.9%) than the researcher's rating (16 or 20.8%). There is also an increase in the *Good* category when using the researcher's rating with two student teachers self-rating as *Good* (2.6%) but when the researcher's rating is used, this number went to 11 or 14.3%. There was also a smaller increase in the researcher's rating category of *None*. 17 definitions (22.1%) were categorised as *None* using the researcher's rating whereas 12 (15.6%) student teachers self-rated their understanding as *None*.

The researcher then investigated if there was a significant difference between these two sets of data. The two sets of rating positions were entered into the data analysis software package *SPSS Statistics (v19)* and a Wilcoxon Signed Ranks Test carried out. This test for statistical

significance was chosen because it was appropriate in this situation where there were non-parametric data and comparison of two related samples required (Investopedia ULC, 2011). By calculating the difference between each set of pairs of data, it was found that there was a statistically significant difference between the student teachers' ratings and the researcher's ratings (p=0.005).

A tally of the responses shows that while 36 student teachers' self-ratings corresponded with the researcher's rating, 10 over-estimated their understanding and 31 of the student teachers under-estimated their understanding. An example of over-estimation is ST37 who wrote:

> *Sustainability is maintaining a state indefinitely.* (ST37)

This response was self-rated as *Reasonable*. However, this response was categorised as *Unqualified/Uncontextualised* because it is a maintenance-type response and using the 'researcher's rating scale', it was rated as *Little*.

An example of under-estimation was:

> *… looking after natural resources. Being aware of and making decisions in order to look after the planet. Involves taking into consideration the future. Realising we only have one planet, our decisions and lifestyles having an impact.*(ST69)

This definition was categorised into the *Resources, Caring for the Environment* and *Future Planning* categories. ST69 rated their understanding as *Little*, but when using the 'researcher's rating scale', it was rated as *Very Good*.

In summary, most of the student teachers' rating positions as determined by the researcher were either *Reasonable, Little* or *None* (63 student teachers) as shown in Table 5.2. Five out of 77 student teachers had a rating position of *Very Good* and nine a rating position of *Good* when using the 'researcher's rating scale'. The way that over half of the student teachers' self-rating positions did not correspond with that of the researcher's rating criteria suggested that this group of student teachers had a low level of awareness of their understanding.

In another question, the student teachers were asked to identify up to five sustainability issues. The results of this question will now be presented.

5.4 Student teachers' identification of sustainability issues

In the questionnaire these student teachers were asked to identify up to five sustainability issues. As with the conceptual indicators, the issues were thematically analysed into ten categories by the researcher. Again, these data are multiple response data. There were a total of 222 issues identified, about three issues per student teacher. The results are presented in Table 5.3.

Table 5.3 Categories of sustainability issues identified, examples of each category, frequency and percentage of identification

Sustainability Issues Categories	Frequency *n*=222	% of Responses
Energy	48	21.6
Resource Depletion	38	17.1
Climate Change	22	9.9
Economic Activity	20	9.0
Pollution	15	6.8
Environmental Degradation	7	3.2
Environmental Restoration	6	2.7
Education about Sustainability	3	1.4
Culture/Traditions	1	0.5
Unrelated and Non-Specific Ideas	62	27.9

Table 5.3 shows that a wide range of issues commonly associated with sustainability was identified by the student teachers. The highest number of responses was placed in the *Unrelated and Non-Specific Ideas* category (62 or 27.9%).

The Energy category contained the second largest number of issues (48 or 21.6%). This category included responses related to types of energy sources such as oil, fuel, fossil fuels and biofuels. Alternative energy sources were also mentioned, such as hydro/wind farms and solar power. Heating was identified and hybrid cars. Mention was also made of the wasting of energy.

The third largest category was *Resource Depletion* (17.1%). This category included issues that related to resources or their use. Although many of the issues identified, such as paper, wood and water usage are the result of resource depletion and are not always regarded as issues themselves, they were still included. They were included because even though they are outcomes, identifying them as issues was considered as showing awareness of their relationship to sustainability. Recycling was also included here because it is about the re-use of resources. Fisheries, forestry and mining were also included in this category because, while they are related to economic activity, these industries involve the harvesting of resources which are not always renewable. Other issues placed in this category included trees, water bottles, plastic and recycling of plastics, clothing, metal and building materials.

The next largest category was *Climate Change* (9.9%). The responses here related to ideas such as global warming, greenhouse gases, carbon dioxide emissions and carbon footprints. *Economic Activity* was the category with the fourth highest number of responses (9%). Ideas that

related to the production of resources such as farming, food production and rubber production were placed in this category along with the construction of commodities such as building, housing and new motorways. Issues of urbanisation and globalisation were also included here.

The fifth largest category was *Pollution* (6.8%) and included ideas such as landfills, rubbish, air and water quality. The next was *Environmental Degradation* (3.2%). This category encompassed those ideas such as deforestation and erosion. Loss of biodiversity was also placed into this category.

Environmental Restoration was the next category (2.7%) and mostly included reference to tree planting. Two of the student teachers identified that they were involved in kiwi release programmes and their responses were included here.

Only 1.4% of the responses were categorised as *Education about Sustainability*. To be included in this category reference had to be made to some type of education related to either sustainability or the environment. The smallest category with only one response (0.5%) was entitled *Culture/Traditions*. This idea was coded as a separate category because preserving a variety of cultures and their associated traditions is considered an important part of the social component of sustainability (Ahlberg, 1998).

The last category and the one with the highest number of responses was entitled *Unrelated and Non-Specific Ideas* (27.9%). This category encompassed ideas that did not relate to sustainability issues, such as "job" (ST60) or "founders/explorers of New Zealand" (ST58), which might have been a sustainability issue in the nineteenth century but is no longer. Other identified issues in the student teachers' responses were non-specific and could not be related to sustainability. Examples of these responses were the word "environment" or "land". The problem with coding these words was that they needed at least another word with them to qualify what was meant. For example, if a student teacher had written 'land quality' then it could have been placed in *Pollution*. Three of the student teachers wrote "Antarctica" and again, this word was difficult to code because of its lack of specific context so was placed into this category.

Twelve of the student teachers left this question blank, seemingly unable to identify an issue. This blank space might have been due to the questionnaire being administered at the end of a two hour lecture and the student teachers running out of time before the start of their next lecture. Alternatively, these student teachers might have found the questionnaire uninteresting, got tired and stopped answering. Of these 12 student teachers, 11 provided no definition either. One student teacher who did not identify any issues (ST48) gave a definition that was categorised as *Resources* and self-rated her understanding as *Reasonable*.

While the student teachers identified a wide range of ideas, many identified issues through the use of one often unqualified word, which could indicate a lower level of understanding. However, these data were only a snapshot and it could be that these student teachers were feeling too rushed to write more than one word or else they didn't think that more than one word was

required. Eleven student teachers used a phrase which added a context and thus appeared to illustrate a deeper understanding of its identification as a sustainability issue. For example, ST32 identified four issues:

> *Mining – coal, gold; milling wood for furniture/building; oil/fuel/natural gas supplies; rubber production* (ST32)

This response could show a deeper understanding because in identifying mining and coupling it with coal and gold, ST32 showed an understanding that mining produced coal and gold, both of which are non-renewable resources. Similarly with ST32's next idea which showed how wood was used as a resource and not all wood comes from certified sustainable plantations. By adding the word "supplies" after "oil/fuel/natural gas", ST32 appeared to be implying that these resources were limited. Finally by adding "production" after "rubber" brings to mind the whole rubber industry with its plantations of rubber trees, large unskilled labour force and factories, each of which could arguably be said to be a sustainability issue. In this way, the use of the extra words qualified the issues and was interpreted by the researcher to mean that ST32 had a more complex notion of sustainability than those student teachers who identified issues using one word.

The student teachers were also asked to identify where they had found information or learnt about sustainability. The results are reported in the next section.

5.5 Sources of information and learning about sustainability

The student teachers were asked to identify where they had found information or learnt about sustainability. There were five categories given on the questionnaire from which to choose and the student teachers could choose more than one, again resulting in multiple response data with a total of 135 responses. These results are reported in Table 5.4.

The results in Table 5.4 show that the student teachers identified the media as the most common source of information (37%) but most giving this response were not specific about the type of media. The next most commonly used source of information was peer and family discussions (24.4%). Formal education was the next most commonly identified source of information (17%), followed by informal education (11.1%). Books were the least common source (10.4%).

The student teachers had the opportunity to specifically identify the source of information for the media, formal education and informal education categories. While only a few student teachers took this opportunity, the results will now be reported as multiple response data. Of those student teachers who specifically identified a form of the media (15 in total), seven identified current events as the most common source of information but did not specify what type of current events. Television programmes were the second most common source (3 responses) and radio was the third (2 responses). Magazines, movies and advertisements were also identified (1 response each).

Table 5.4 Sources of information or places learnt about sustainability identified by the student teachers

Category	Frequency *n*=135	% of responses
Media	50	37.0
Peer/Family discussions	33	24.4
Formal education	23	17.0
Informal education	15	11.1
Books	14	10.4

Types of formal education were identified (10 responses in total) with secondary education identified the most frequently (5 responses). Learning about sustainability in the school subjects of geography and biology were mentioned, as was participation in an eco-school envirogroup. Three of the student teachers identified tertiary education as a source of information but gave no further details. Primary education was identified by two of the student teachers as a source.

Informal education was the last sources of information category (5 responses in total). Three of the student teachers identified professional development while on practicum as a source of information. A local council-run course was also identified by one student teacher. Lastly, attendance at an environmental education conference was identified as a source of information by one student teacher. It is interesting to note that none of student teachers indicated that they had used the web to search for information about sustainability.

Finally the researcher investigated where those student teachers who had a researcher's rating position of *Very Good Plus,Very Good,* or *Good* had either sourced their information or learnt about sustainability to see if there was a 'best' source of information given their understanding rating position. While it was found that all of these student teachers had identified the media as one of their sources of information, no other patterns were found.

5.6 Chapter summary

This chapter presented the findings related to the first of the research questions: What are primary student teachers' understandings of sustainability? The complex nature of sustainability was illustrated by the variety of ideas expressed by the student teachers. However, most of the student teachers had a simplistic view of sustainability with 52 out of 77 expressing definitions about sustainability that contained one conceptual indicator. A conceptual indicator was regarded as a word or phrase that expressed a teacher participant's understanding of sustainability. The challenge of understanding sustainability was also demonstrated by the way that 61 out of 77 student teachers had an understanding rating of *Reasonable, Little* or *None* using the researcher's scale. In addition, their superficial understanding was illustrated by the way that all

but 11 of the student teachers used only one unqualified word when describing issues associated with sustainability.

Two tools were developed to analyse the student teachers' levels of understanding. The 'definition content analysis tool' shown in Figure 5.3 allowed the researcher to analyse the content of the student teachers' definitions and the 'researcher's rating scale' shown in Figure 5.2 enabled the researcher to establish levels of understanding about sustainability. These two tools appeared to be effective because they allowed the researcher to consistently and rigorously interpret the data (Braun & Clarke, 2006) and then make decisions about levels of understanding. The researcher was not dependent upon personal decisions because there was a set of criteria to follow.

The theoretical definition of sustainability developed by the researcher was used to analyse the data. By incorporating components of the theoretical definition into the 'definition content analysis tool', the researcher was able to examine the student teachers' definitions for these components and then make judgements about their levels of understandings.

These two tools will now be used to analyse any changes in those student teachers' understandings of sustainability who decided to participate in a series of workshops focused on sustainability. The findings will be presented in the next chapter.

Chapter 6: Measuring Development of the Student Teachers' Understandings of Sustainability

6.1 Introduction

This chapter presents the findings to answer the second of the research questions: How can student teachers' understandings of sustainability be developed? A series of workshops were designed by the researcher to provide opportunities for these student teachers to develop their understanding about sustainability and to introduce them to sustainability-linked pedagogical strategies. Data analysis tools were used to measure changes that occurred in their understandings and the workshop activities were evaluated in terms of their potential to generate change.

This chapter also presents the findings about these student teachers' emerging identities as teachers of education for sustainability. This exploration of identity relates to the fifth research question: How does their understanding of sustainability affect student teachers' sense of identity as EfS teachers? Their emerging identities were considered important because Cohen (2010) and Beijaard et al. (2004) argue that how teachers perceive themselves affects their pedagogy. I propose that learning about sustainability could change their perceptions and it is hoped that such change could result in a change in their pedagogy. Another tool was developed to measure their identity as EfS teachers.

After completing the initial questionnaire designed to ascertain a base-line indication of their understandings of sustainability, the student teachers were invited to attend a series of workshops. Twenty-one student teachers decided to take part. A series of three workshops were held a week apart. Data relating to their developing understandings of sustainability were collected by repeating the questionnaire, peer interviews and individual semi-structured interviews at the end of the workshops.

These student teachers were interviewed about how their participation in the workshops might impact on their future pedagogy and the most important thing that they had learnt during the workshops. They were also asked if their workshop participation had influenced any of their lifestyle decisions outside of teaching. These questions were asked because it was hoped that this information would enable the researcher to gain an insight into the development of these student teachers' emerging identities as teachers of education for sustainability.

6.1.1 Chapter structure

This chapter begins with an outline of the workshop activities and their relationship to relevant learning theory in Section 6.2. The student teachers' reasons for participating are analysed in Section 6.3. Changes to the student teachers' understandings of sustainability, their self-ratings and researcher's ratings of their understandings of sustainability as well as the issues identified

are presented in Section 6.4. In Section 6.5 the most important concept learnt by each student teacher during the workshops is presented and the potential impacts on the student teachers' future pedagogy are discussed in Section 6.6. Effects on the personal lifestyle choices of the student teachers are presented in Section 6.7. An analysis of these student teachers' emerging identity as EfS teachers is presented in Section 6.8.

6.2 Outline of workshop activities and justification of use

Three workshops were held once a week over three weeks. They lasted about one and a half to two hours. The first activity, completed individually, was a picture sorting activity (Appendix C). This activity was carried out at the beginning in order to find out what these student teachers knew about sustainability. According to constructivist learning theories, it is important to find out what learners know at the beginning of learning, so that their ideas could be modified and changed (Skamp, 2008). It was hoped that this activity would clarify student teachers' ideas about sustainability, so that they had a reference point on which to start to consider new ideas about sustainability during the workshops.

Next the researcher presented a Powerpoint display about sustainability (Appendix D) that introduced the definition of sustainability developed for this project (p. 24). The display was presented in order to show them alternative ideas about sustainability that might challenge their existing ideas, or construing of meaning (Mezirow, 1990) and set up cognitive dissonance. Because people find cognitive dissonance unpleasant and work to reduce it by making their ideas more consonant (Aronson, 1969), it was hoped that viewing this presentation might lead to them considering new ideas about sustainability.

They were then given the opportunity to re-group their picture cards. This re-grouping gave them time to critically reflect upon their existing ideas in the light of the new ideas about sustainability contained in the Powerpoint. It was hoped that they could possibly begin to develop their understanding of sustainability. Mezirow (1990) argues that such critical reflection is essential as it can lead to a transformation in ideas.

Finally, they assembled a sustainability jigsaw in groups and discussed the way it represented sustainability (Appendix E). Participating in the jigsaw activity provided the student teachers with another opportunity for critical reflection. It also gave them the chance to discuss their ideas with each other, or, in terms of Mezirow's transformative learning theory (2003), engage in rational discourse. Such discussion was seen by the researcher as important because it gave them opportunities to assess each other's ideas about sustainability in relation to their own and arrive at a judgement of them. According to Mezirow, this process can lead to learning, or in the case of this project, a development in their understandings of sustainability.

The second workshop began with a consequence wheel activity set in the context of setting up a waste reduction programme in a school (Appendices F and G). This activity was also designed to provide opportunities for critical reflection by encouraging the student teachers to think about the

effects of implementing waste reduction programmes and the consequences of those effects both on the school, its wider community and on the future. Again, it was hoped that such critical reflection would affect their understandings.

The next activity was a diamond ranking activity using nine cards with pictures of instances and non-instances of sustainability (Appendix H). Once more, this activity provided opportunities for critical reflection about their ideas of sustainability. Because the student teachers had to place these pictures into a particular structure, they had to reflect on their values and make decisions about the relative ranking of each instance of sustainability. It was hoped that such reflection and decision-making could lead to cognitive dissonance and a re-assessment of their current ideas.

Finally these student teachers were given a media article (Appendix I) and were asked to identify examples of the three components of sustainability: either environmental, social, economic or combinations of the three. Again, there was opportunity for critical reflection about their ideas of sustainability as they interpreted the components and their interrelationship in the context of a particular issue with the hope of them re-considering their current notions of sustainability.

During the final workshop peer interviews were conducted. Student teachers interviewed each other using the question guidelines supplied by the researcher (Appendix J). Similarly to the jigsaw activity, these interviews were an opportunity for rational discourse (Mezirow, 2003). As they were discussing their ideas about sustainability and their future pedagogy with each other, it was anticipated that they could be reflecting on the new ideas and on their peer's ideas while making judgements and possibly deepening their ideas about sustainability. Table 6.1 sets out each activity and relates it to the appropriate elements of transformative learning theory that have been explained in detail in Chapter 3 (pp. 50-3).

During the peer interviews the student teachers asked each other why they had decided to participate in these workshops. These results will be presented in the next section.

6.3 Reasons for participation in workshops

Of the 77 student teachers who completed the anonymous questionnaire, 21 chose to take part in the workshops. Peer interviews provided information about why these student teachers had decided to participate. They were asked this question because the researcher hoped it could provide information about their interest in sustainability which could be linked to their identities. After transcription, the data was analysed by the researcher using thematic analysis (Braun & Clarke, 2006) and verified by a colleague. The reasons given for participation will now be presented and because many of the student teachers gave more than one reason, the data are presented as multiple response data providing a total of 35 responses.

Table 6.1 Description of workshop activities and links to elements of constructivist and transformative learning theories

Activity	Description	Learning Theory Element Links
Picture sorting cards	Provided visual aids to stimulate identification of prior ideas. Tape recorder provided as an opportunity to clarify and record ideas.	Constructivist-linked learning – elicitation of prior ideas about sustainability so that student teachers were aware of their ideas as a starting point for learning (Skamp, 2008).
Researcher's presentation about sustainability	Presented ideas about sustainability including the theoretical definition developed for this project.	Transformative learning – construing of meaning element (Mezirow, 1990) where student teachers were presented with alternative ideas about sustainability that challenged the student teachers' existing ideas to create cognitive dissonance (Aronson, 1969).
Re-sort of picture sorting cards	Provided opportunity to critically reflect on their current ideas in light of researcher's presentation and then explore different ways of grouping the cards.	Transformative learning – critical reflection about existing ideas and new ideas about sustainability presented by researcher, possibly leading to a change in their ideas about sustainability as they work towards consonance of ideas (Aronson; Mezirow).
Jigsaw	An opportunity to critically reflect on their current ideas and discuss their ideas with others. The visual task provided an illustration of a model of sustainability and the interrelationship between the three sustainability components.	Transformative learning - critical reflection on existing and new ideas. Rational discourse with others about own and others' ideas, arriving at judgements which could lead to developing ideas about sustainability (Mezirow, 2003).
Consequence wheel	Student teachers were provided with the opportunity to think about the effects and future consequences of implementing a waste reduction programme on the school, the wider community and on the future.	Transformative learning - critical reflection on their current ideas of sustainability. It was designed to set up cognitive dissonance to re-assess their ideas, and could possibly lead to change in their ideas about sustainability (Aronson; Mezirow)
Diamond ranking	An opportunity to clarify values by ranking instances and non-instances of sustainability within a set structure that required decision-making.	Transformative learning - critical reflection enabled them to consider their current ideas about sustainability in the context of the pictures (Mezirow). It was designed to set up cognitive dissonance (Aronson) to lead to them to re-assess their ideas and might result in a change to their ideas about sustainability.
Newspaper article	Provided student teachers with the opportunity to interpret the three components of sustainability and their interrelationship when considering an issue.	Transformative learning - opportunity to identify sustainability components in a 'real-life' issue and critically reflect on their interpretation of the components and interrelationship in a context (Mezirow). It was hoped that this reflection could lead to a development in their ideas about sustainability.
Peer interviews	Provided student teachers with opportunities to discuss ideas about sustainability and their future pedagogy with each other.	Transformative learning - rational discourse - by assessing other student teachers' ideas about sustainability, they could think about their understanding of sustainability, ways it might have changed and about its impacts on their future pedagogy (Mezirow).

There were three categories of reasons: *Personal Professional Development*, *Future Pedagogy*; and *Personal Gain*. The largest number of responses was coded into the *Personal Professional Development* category (21 responses or 60%) with the *Future Pedagogy* category containing 22.9% (8 responses) and *Personal Gain* 17.1% (6 responses). A thematic map of the reasons is presented in Figure 6.1.

Responses that were coded in the *Personal Professional Development* category related to student teachers wanting to develop a personal understanding about sustainability (12 responses or 34.3%). For example:

> *… at first I wasn't too sure if I would or not when I first heard about it, but then after thinking about it I thought that it would probably be something that would be quite worthwhile because I didn't actually have any understanding of what sustainability was.* (Pansy)

Pansy's response shows her initial ambivalence about participation but then she decided to participate because she wanted to learn about sustainability. Ivy also decided to participate because she wanted to develop her understanding about sustainability recognising her current lack of knowledge:

> *I needed to learn about sustainability. I had no idea about anything to do with sustainability.* (Ivy)

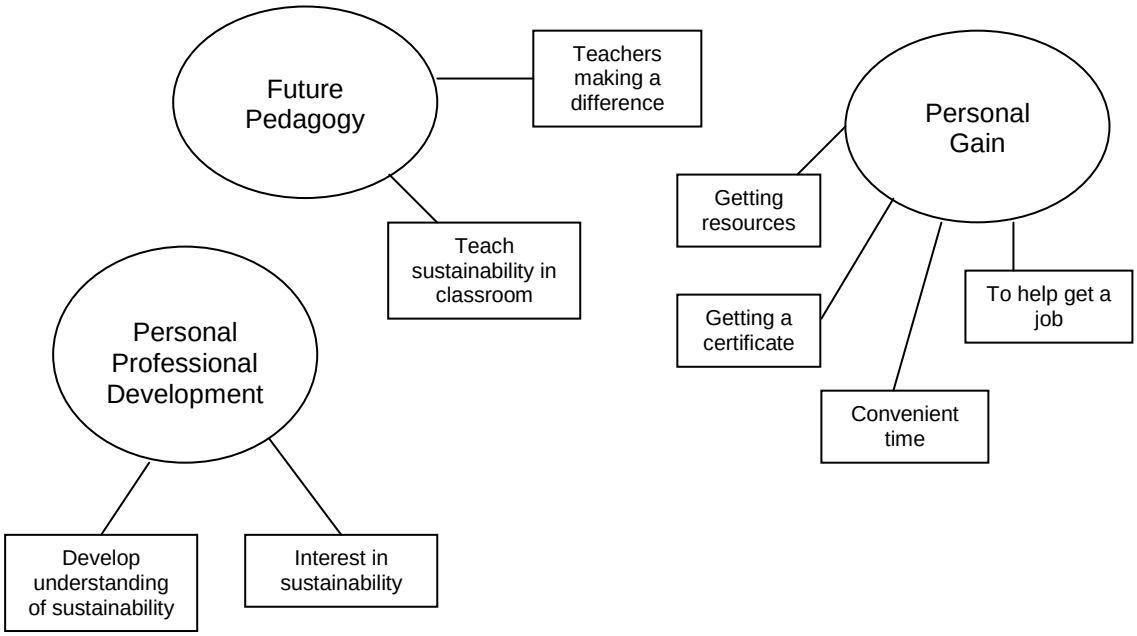


Figure 6.1 Thematic map of reasons for participation in workshops

Others expressed having an interest in the topic (7 responses or 20%). An example of this type of response is Poppy's where she stated that sustainability was of interest to her, so much so that

she had begun incorporating unspecified sustainable practices into her lifestyle in order to improve the environment and the Earth's future:

> *I've really been quite interested in it and as of late, I've really started doing things myself that hopefully are bettering the environment and future and reducing my carbon footprint …* (Poppy)

Rose also decided to participate because of her interest in sustainability:

> *… I've always been very interested in sustainability …* (Rose)

The next largest category of responses, *Future Pedagogy*, related to responses expressing ideas about teaching sustainability in their future pedagogy. For example, Violet stated:

> *… I think that it's definitely something that I'll teach every year in my classroom … you go into all schools and they're doing stuff like this now. I didn't really have a clue where to start teaching it ...* (Violet)

In her response Violet indicated that she intended to teach sustainability as part of her classroom programme. Her response also showed that she believed many schools were teaching about environmental issues and she wanted to learn how to teach about these too. One student teacher expressed the belief that teachers made a difference and gave this reason for participating which was also placed in the *Future Pedagogy* category:

> *I feel that sustainability is a big issue that we need to address. I think as a teacher we can make a difference, we can educate our students so that they possibly could make a difference in the world.* (Alyssa)

Not only did Alyssa indicate that she intends to teach sustainability because she thinks it is important, she demonstrated a pedagogical philosophy about teachers having an influence on their children's actions. In addition, her response revealed her beliefs and values about sustainability and how her personal beliefs and values might impact on her future pedagogy.

The final category, *Personal Gain*, included responses that related to them acquiring resources or a certificate of attendance, or else a hope that attendance might help secure a teaching position. Another group took advantage of the opportunity because the workshops were held at a convenient time. Examples of such responses were:

> *… it was for the resources …* (Iris)
>
> *… I was interested in receiving a certificate.* (Holly)
>
> *I actually thought that it would help me get a job …* (Briar)
>
> *Like Willow, I had a huge gap between my lectures and it was an opportunity to take up the workshop …* (Petunia)

In summary, this analysis showed that these student teachers had a wide range of reasons for deciding to participate in the workshops with the majority wanting to learn about sustainability or else having an interest in it.

The workshop activities were designed to deepen these student teachers' understandings of sustainability and the effects of their participation will now be discussed.

6.4 Effects of participation on the student teachers' understandings of sustainability

The main focus of the workshops was to develop student teachers' understandings of sustainability. Data were collected from the workshop activities in order to track their developing understandings. The researcher hoped that the student teachers' understandings would develop in complexity as a result of their participation. She planned to measure development by examining the conceptual indicators contained in the student teachers' post-workshop definitions.

This section will firstly present a comparison between the student teachers' understandings of sustainability before and after participation in the workshops using conceptual indicators as a measure in Section 6.4.1. In Section 6.4.2 a comparison will be made between their initial and post-workshop definitions using components of the researcher's theoretical definition. A comparison between their self-ratings of understanding before and after participation will be presented in Section 6.4.3. Then a comparison will be made with the researcher's rating to investigate correspondence between the two. Another comparison will be made between the sustainability issues identified by the student teachers before and after their participation in Section 6.4.4. During the peer interviews, the student teachers were asked what activity or activities had the most impact on their learning and why. These results will be then presented in Section 6.4.5.

6.4.1 Changes to the student teachers' understandings of sustainability using conceptual indicators

Re-answering the questionnaire provided data to compare the number of conceptual indicators in the definitions expressed by the student teachers at the start of the project and the number of conceptual indicators in their definitions given at the end of the workshops. A conceptual indicator was a word or phrase used by a student teacher that gave their ideas about sustainability. These conceptual indicators formed themes that were then placed into categories shown in Table 5.1 on p. 87. An example of a conceptual indicator is Ivy's initial definition:

> *Sustainability to me means to maintain something.* (Ivy)

Ivy's idea about sustainability, or conceptual indicator, was related to a dictionary-type definition of sustainability and was placed in the *Unqualified/Uncontextualised* category and coloured blue-grey.

The researcher decided that an increase in the number of conceptual indicators within their definitions could be indicative of development of complexity in the student teachers' understandings of sustainability. Table 6.2 presents the numbers of conceptual indicators in the definitions given by these student teachers in their initial and post-workshop questionnaires. Those student teachers whose numbers of conceptual indicators in their definitions changed are in colour. The student teachers whose post-workshop definitions did not show evidence of an increase in use of conceptual indicators are in black.

The data in Table 6.2 show the changes in numbers of conceptual indicators given in these student teachers' definitions. In the initial questionnaire, two of the student teachers left the space for a definition blank but no student teacher did this in the post-workshop questionnaire. Twelve student teachers provided one conceptual indicator in the initial questionnaire but this number dropped to nine student teachers who provided one conceptual indicator in the post-workshop questionnaire. Six student teachers gave two conceptual indicators in the initial questionnaire and in the post-workshop questionnaire, this number rose to 10. No student teacher provided three conceptual indicators in the initial questionnaire but one was able to do so in the post-workshop questionnaire. One student teacher, Violet, provided four conceptual indicators in her definition in both the initial and post-workshop questionnaires.

Table 6.2 Comparison between the number of conceptual indicators given in the student teachers' definitions of sustainability in the initial and post-workshop questionnaires

Data Generation Tool	No Conceptual Indicators	1 Conceptual Indicator	2 Conceptual Indicators	3 Conceptual Indicators	4 Conceptual Indicators
Initial Questionnaire	Briar*, Pansy	Daisy, Clover, Fern**, Fleur, Hazel, Ivy, Jasmine, Lily, Petunia, Poppy, Posy, Willow	Alyssa, Holly, Iris, Marigold, Rose, Rowan		Violet
Post-workshop Questionnaire		Alyssa, Briar, Fern, Hazel, Jasmine, Lily, Petunia, Rowan, Willow	Clover, Daisy, Fleur, Holly, Iris, Ivy, Marigold, Pansy, Posy, Rose	Poppy	Violet

Notes. * Student teachers whose definitions showed a change in number of conceptual indicators are in a specific colour for each student teacher for easy location

** Student teachers whose definitions showed no change in number of conceptual indicators are in black

Table 6.2 shows that seven student teachers were able to include more conceptual indicators in their definitions of sustainability in the post-workshop questionnaire. These data indicate a deepening in their understanding. Of the seven, five were able to give one extra conceptual indicator in their definitions and two were able to give two extra conceptual indicators. Poppy was

an example of a student teacher whose number of conceptual indicators increased by two. Her initial definition contained one conceptual indicator:

> *Reduce, reuse, recycle – rather than making more and more stuff which gets wasted into the environment – looking at other ways we can live off our land …* (Poppy)

This conceptual indicator was placed in the *Resources* category because of its reference to recycling and reducing consumption of resources and coloured red. It can be regarded as a sophisticated *Resources* response because Poppy showed an understanding that many resources are wasted and could be implying that such wastage fills up landfills by her reference to "wasted into the environment". Poppy also showed an awareness of a possible solution to waste by suggesting that people live off their land. Her post-workshop definition contained three conceptual indicators, an increase of two:

> *Looking at ways we as people can create a more sustainable future: living off home grown food rather than buying from overseas, etc. and looking at impacts that not being sustainable has on the future and environment.*(Poppy)

Firstly, Poppy incorporated the temporal nature of sustainability into her definition by her reference to people creating a "more sustainable future" and people examining the consequences of their actions on the future. This conceptual indicator was placed in the *Future Planning* category and coloured blue. Poppy also suggested that part of creating a sustainable future was growing your own food. Doing so is regarded by some as reducing one's environmental impact because commercial horticulture is often seen as unsustainable due to its use of fertilisers, pesticides and monoculture practices. It could also assist in reducing people's dislocation from nature by re-connecting them to food production processes (p. 6). This conceptual indicator was placed in the *Lifestyle Choices* category and coloured orange. Poppy also made reference to the impact on the environment of unsustainable practices but does not qualify what she means by this statement. This third conceptual indicator was placed in *Caring for the Environment* category coloured green.

Five of the student teachers had an increase of one in the number of conceptual indicators used in their post-workshop definitions which could indicate a deepening in their understanding. An example of a student teacher who increased their number of conceptual indicators by one was Clover. Her initial definition contained one conceptual indicator:

> *Conserving resources, reducing usage of natural material and produced products.* (Clover)

Because of its reference to resources, this conceptual indicator was placed in the *Resources* category. It was regarded by the researcher as a sophisticated *Resources* response because Clover also mentioned that sustainability involved reducing consumption of both natural and man-made resources which could be indicative of her understanding that resources are limited. In her

post-workshop definition Clover was able to use two conceptual indicators in her definition, an increase of one:

> *Using natural resources to preserve and conserve the environment. Being aware of the impact of unsustainable resources on the natural environment.*(Clover)

The first part of this sentence was placed into the *Resources* category because of its reference to the use of natural resources. This sentence also seems to imply that the use of such resources will result in conservation of the environment but no mention is made of how. Because reference was made to preserving the environment, this part of the sentence was regarded as part of the second conceptual indicator and placed in *Caring for the Environment*. The remainder of Clover's definition mentioned the environmental impact of unsustainable resources and this part of the second conceptual indicator was also placed in the *Caring for the Environment* category. It is not clear what "unsustainable resources" meant here but it could be referring to nonrenewable resources and the environmental impact of such resources running out or else their disposal.

Twelve of the student teachers' numbers of conceptual indicators did not change which suggested that their understanding did not develop in complexity. For example, Iris's initial definition contained two conceptual indicators:

> *Making sure that we don't use all of our resources. Thinking ahead to the future whether it [will] be with petrol/oil/trees.* (Iris)

The first sentence in this response was categorised as *Resources* because of its reference to ensuring that we do not use up all of our resources. Her second sentence was placed into the *Future Planning* category because she wrote about looking ahead to the future and wondering about what type of resources would still be available. Iris's post-workshop definition was also comprised of two conceptual indicators and she stated:

> *Using and maintaining resources for the future. Not letting social/cultural and economic factors impact too much on the environment. If we do the environment will collapse and we will all be screwed!* (Iris)

Iris's first sentence was categorised as *Resources* because again she has referred to ensuring a supply of resources but it is also a sophisticated response in that she included a temporal scale. The second sentence was categorised as *Interrelationship of Components* and coloured turquoise since Iris shows a somewhat irreverent understanding that the environmental component of sustainability is the most important because if either society or the economy has too much of an impact, then life might not be able to continue.

However, although the number of conceptual indicators that Iris used did not increase, her understanding seemed to change and deepen because in her post-workshop definition she mentioned the interrelationship of the three sustainability components which according to 'researcher's rating scale', is a more sophisticated understanding than her use of a *Resources*

and *Caring for the Environment* response in her initial definition. For this reason, the researcher supposed that a count of conceptual indicators might not be giving sufficient detail about the development of the student teachers' understandings.

The researcher thought about reasons why a count of conceptual indicators might not be giving sufficient detail. A possible reason could be that the conceptual indicators were themes that emerged from the student teachers' definitions and these themes were then placed in categories (See Table 5.1 p. 87). The categories were not ranked in order of complexity of understanding and consequently just using the conceptual indicators alone might not reflect the way in which some student teachers' understandings developed.

This limitation was also evident when examining two of the student teachers' definitions whose post-workshop definitions showed a decrease in the number of conceptual indicators. Rowan, for example, had two conceptual indicators in her initial definition but only one in her post-workshop definition. In her initial definition she wrote:

> *Sustainability refers to the effective use of resources which takes into account the environment. Themes such as recycling, eco-footprints and power conservation are entwined within the concept.* (Rowan)

Most of this definition was categorised as *Resources* due to its reference to use of resources. Rowan has also provided examples related to resources such as recycling and power conservation. Her definition also contained a conceptual indicator that was categorised as *Caring for the Environment* because she linked use of resources with consideration of the environmental impact of such use. It appears to be implying that effective use will have minimal environmental impact.

Her post-workshop definition only had one conceptual indicator:

> *Sustainability is a concept which incorporates and infers humans need to reduce their negative impacts on the environmentin order so that the environment is preserved for future generations to inhabit.* (Rowan)

This definition was categorised as *Intergenerational Equity* and coloured lavender because of its reference to caring for the environment so that future generations would be able to live on Earth and Rowan appears to have synthesised her ideas about resources and caring for the environment as well as including a temporal aspect.

As with Iris's definition, a simple count of conceptual indicators used did not show the development of Rowan's understanding. Her post-workshop definition can be regarded as more sophisticated because it is an *Intergenerational Equity*-response. This type of conceptual indicator was ranked more highly on the 'researcher's rating scale' than *Resources* or *Caring for the Environment*.

Due to the way that a count of the conceptual indicators did not always seem to provide sufficient detail about the development of the student teachers' understandings of sustainability, the researcher decided to analyse their definitions in terms of the components of sustainability presented in the researcher's theoretical definition. The findings of this analysis will be presented in the next sub-section.

6.4.2 Changes to the student teachers' understandings of sustainability using the components of the researcher's theoretical definition

Next the researcher compared the number of components in the student teachers' initial and post-workshop definitions. Components refers to the components of sustainability given in the researcher's theoretical definition, namely environmental, social (including cultural), economic, interrelationship between these three components and temporal. The researcher hoped that a count of these components could indicate development of understanding because they were parts of the theoretical definition used in the workshops. She also decided that if the number of components contained in these student teacher's definitions had increased, this could indicate a development in the complexity of their understanding. The results of this analysis are presented in Table 6.3.

The data in Table 6.3 show that most of these student teachers were able to include more of the researcher's theoretical definition components in their post-workshop definitions. For example, in the initial questionnaire, seven student teachers' definitions did not contain any of the researcher's theoretical definition components but in the post-workshop questionnaire, no student teachers' definition was categorised in this way. Eight of the student teachers' initial definitions contained one component and four of the student teachers' post-workshop definitions contained this number. While five student teachers' initial definitions contained two components, 15 of the student teachers' post-workshop questionnaires contained two components. There was a slight increase in the number of student teachers incorporating three components in their definition, going from one in the initial questionnaire to two in the post-workshop questionnaire.

Table 6.3 Comparison of the number of components in student teachers' definitions of sustainability in the initial and post-workshop questionnaires

Data Generation Tool	No Components	1 Component	2 Components	3 Components
Initial Questionnaire	Briar, Fern, Fleur, Ivy, Jasmine, Pansy, Willow	Clover, Hazel, Holly, Lily, Marigold, Poppy, Posy, Rose	Alyssa, Daisy, Iris, Petunia, Rowan	Violet
Post-workshop Questionnaire		Clover, Fern, Jasmine, Willow	Alyssa, Briar, Daisy, Fleur, Hazel, Holly, Ivy, Lily, Marigold, Pansy, Petunia, Poppy, Posy, Rose, Rowan	Iris, Violet

Notes. *Names in pink denote an increase of 1 component in post-workshop definition.*
Names in blue denote an increase of 2 components in post-workshop definition.
Black denotes no change in number of components.

The results of this analysis show that 16 of the student teachers increased the number of components in their post-workshop definitions and this could suggest that many of these student teachers' understandings of sustainability had developed in complexity. Four student teachers' post-workshop definitions contained an increase of two components (coloured blue in the table).

An example of a student teacher who increased the number of components in her post-workshop definition by two was Fleur. Her initial definition stated:

> *To sustain natural phenomenas (preserve).* (Fleur)

Fleur's definition was placed in the *Unqualified/Uncontextualised* category because of its mention of simply maintaining something and it did not contain any components of the researcher's theoretical definition. Following the workshops, Fleur was able to include two components in her definition:

> *Sustainability is to sustain resources (natural). The environment is the most important because if the environment collapses so will the social, cultural and economy.* (Fleur)

The first component was environmental because of her reference to sustaining natural resources (*Resources*). This statement provided evidence of a deepening of understanding. Originally she stated that sustainability was about sustaining "natural phenomenas" but she has shifted her view to stating it is about sustaining "resources (natural)". The second component is reference to the interrelationship of the components with her reference to environment, society, culture and the economy. This conceptual indicator was placed in the *Interrelationship of Components* category and showed that Fleur privileges the environment over the other sustainability components. She also included the cultural component of sustainability.

Eleven student teachers' post-workshop definition components increased by one (coloured pink in the table) and an example of this type of increase was Fern. Her initial definition did not contain any of the researcher's theoretical sustainability components:

> *Keeping things the same.* (Fern)

Fern's initial definition was placed in the *Unqualified/Uncontextualised* category due to its reference to simply maintaining something. Her post-workshop definition contained a component of the researcher's definition:

> *Sustainability to me means preserving what we have on this planet. Anything we now take we must replace.* (Fern)

This definition was categorised as *Resources* and relates to the environmental component of the researcher's theoretical definition. Although no direct reference to resources was made, Fern does refer to replacing what has been used and husbanding what we have, which is indicative of an understanding about conserving resources.

Six of the student teachers' numbers of definition components remained the same (coloured black in the table). Daisy's definitions are an example and in her initial definition she wrote:

> *Looking after the environment to sustain it over time.* (Daisy)

This definition contains two of the researcher's theoretical components. The first component is the environmental one where Daisy refers to "looking after" it. This statement referred to people taking on a guardianship role and was placed in the *Caring for the Environment* category. Daisy has also incorporated a temporal scale into her definition by mentioning the need to care for the environment so that it lasts but no specified temporal scale was used.

In her post-workshop definition she wrote:

> *Sustainability is based around environmental, economic and societal aspects of the world with the creation of systems that contribute to the continuation of life that is sustainable long term.* (Daisy)

Again, this definition contains two components. The first component is the interrelationship of components where Daisy referred to sustainability being comprised of the three sustainability components. This part of Daisy's definition was placed in the *Interrelationship of Components* category. Daisy also mentioned that by incorporating these three components into systems, life would continue in the long term. The reference to the long term is implicit of the future or temporal nature of sustainability, which was the second component used.

However, Daisy's post-workshop definition did appear to illustrate a development in the complexity of her understanding because she referred to the interrelationship of the three sustainability components, which was regarded as a more sophisticated idea than caring for the environment when using the 'researcher's rating scale'. Also, by referring to the "continuation of life … over time" her temporal component has been qualified which could be indicative of a deepening of understanding.

This analysis showed the value of using the researcher's theoretical definition in these workshops as well as an analysis tool. The researcher was able to analyse the definitions in terms of the components used and this enabled the researcher to identify development in the complexity of the student teachers' definitions. It also enabled the researcher to show the range of complexity across their definitions. However, while the count of components did show that more student teachers' understandings seemed to deepen, further analysis is needed.

In summary, it is postulated that because 16 of the 21 student teachers were able to include more of the researcher's theoretical components of sustainability into their post-workshop definitions, it would suggest that most of these student teachers' understandings of sustainability developed in complexity. However, a tally of components still did not seem to show a full picture of the changes to their understandings. Because of this situation, the student teachers' self-ratings before and after the workshops will be investigated along with their correspondence with the

researcher's rating in order to explore the depth of the student teachers' developing awareness of their understandings of sustainability.

6.4.3 Changes to the student teachers' ratings of their understanding of sustainability

In both the initial and post-workshop questionnaires, they were asked to rate their understanding of sustainability on a five-point scale, from *Little* through to *Very Good*. The researcher decided that if there was a shift in the student teachers' ratings of their understanding towards the *Very Good* end of the scale, then this shift could indicate that they were developing a greater awareness of their understandings of sustainability.

Two rating scales are used in this sub-section. The first rating scale is the one that the student teachers used to self-rate their understanding. It had five rating points, namely *None, Little, Reasonable, Good* and *Very Good*. The second scale is the one used by the researcher to rate the student teachers' understandings entitled the 'researcher's rating scale'. The researcher developed this scale because during the analysis of the initial questionnaire, she noted that some of the student teachers' self-ratings did not correspond with what she would have rated that definition. Therefore, using the categories developed to code the conceptual indicators, the researcher developed the 'researcher's rating scale' (Figure 5.2 p. 92) and a 'definition content analysis tool' (Figure 5.3 p. 93). The 'researcher's rating scale' and 'definition content analysis tool' were then used to analyse these student teachers' post-workshop ratings of their understandings for evidence of change.

Firstly this section will examine any changes that the student teachers made to their self-rating of understanding of sustainability following their participation in the workshops. Next the correspondence of their self-ratings with the researcher's ratings will be investigated and examined for evidence of a growing awareness of their understandings of sustainability.

The student teachers' self-ratings of their understanding appear to show that in general, they thought that the workshops had resulted in a deepening of their understanding of sustainability. When the student teachers' self-ratings in the post-workshop questionnaire were compared with their self-ratings in the initial questionnaire, it was found that 16 reported a change towards a more complex understanding with five reporting no change. No one reported a change towards the *None* end of the rating scale. However, when the 'researcher's rating scale' was used together with the 'definition content analysis tool', the changes to the ratings of their understandings of sustainability were even greater. This analysis showed that 19 of the student teachers' understandings had shifted towards the *Very Good* end of the scale and two of the student teachers' understandings of sustainability had not changed (Violet and Petunia). These results are reported in Table 6.4.

This shift to a more sophisticated level using the researcher's scale is shown in Table 6.4 and could indicate development of their awareness of the complexity of the concept of sustainability and be recognition of what they had learnt during the workshops. Awareness of one's

understanding is important in teaching because if these student teachers perceived that they knew more about sustainability, then this understanding could give them more confidence to include it in their pedagogy. Table 6.4 shows that six of the student teachers had an initial understanding rating of *None* or *Little* using the researcher's rating but by the end of the workshops, no student teacher's understanding was rated as *None* or *Little*. In the initial questionnaire, seven had an understanding rating of *Reasonable* and seven had a rating of *Good*. Following the workshops no student teacher had an understanding rating of *Reasonable*. Nine had a rating of *Good* and 11 had a rating of *Very Good*. Only one student teacher (Violet) had an initial understanding rating of *Very Good Plus* and this remained unchanged following the workshops. The two student teachers whose understanding rating did not change are in colour.

Table 6.4 Shift in the student teachers' understandings of sustainability before and after the workshops using the researcher's rating

Data Generation Tool	None	Little	Reasonable	Good	Very Good	Very Good Plus
Initial Rating	Briar, Pansy	Fern, Ivy, Jasmine, Willow	Clover, Daisy, Fleur, Hazel, Lily, Posy, Rowan	Alyssa, Iris, Holly, Marigold, Petunia*, Poppy, Rose		Violet*
Post-workshop Rating				Briar, Clover, Fern, Hazel, Jasmine, Lily, Petunia	Alyssa, Daisy, Fleur, Iris, Holly, Ivy, Marigold, Pansy, Poppy, Posy, Rose, Rowan, Willow	Violet

Note. * Denotes no change in the researcher's rating of their definition

As reported in Chapter 5 (p. 82), when the student teachers completed the initial questionnaire, there was a statistically significant difference between the student teachers' self-rating of their initial understanding and the researcher's rating of their understanding. Forty-one out of 77 student teachers' self-ratings did not correspond with the researcher's rating of their understanding of sustainability. Since most of these student teachers' understandings of sustainability seemed to have developed in complexity, the researcher investigated whether the student teachers' post-workshop self-ratings would correspond with the researcher's ratings.

In the initial questionnaire, four of the student teachers' self-ratings corresponded with the researcher's rating, 13 under-estimated their rating and four over-estimated their rating. When

rating themselves after the workshops, many of the student teachers' self-ratings still did not correspond with the researcher's rating. While a total of six did correspond with the researcher's rating, 15 under-estimated their understanding of sustainability. This time, no student teacher over-estimated their understanding following the workshops.

These results suggest that even after participating in the workshops that aimed to deepen their understanding, 15 were still not able to self-rate their understanding in a way that corresponded with the researcher's rating. This under-estimation could suggest that these student teachers had become more aware of the complex nature of sustainability and realised that their understandings lacked depth, even though their understandings had developed in complexity. For example Hazel's post-workshop rating went from *Reasonable* to *Good* when using the researcher's rating and this analysis is shown in Figure 6.2.

Her initial definition was a simple response that contained reference to sustainability as actions that have no environmental impact which related to the researcher's theoretical environmental component:

> *Sustainability – doing something that doesn't impact on our environment.* (Hazel)

However, while her post-workshop definition also contained reference to environmental impact, it was more sophisticated and contained two of the researcher's theoretical definition components and could be regarded as a development in her understanding. Hazel wrote:

> *Sustainability – living and interacting with the environment so as to cause little or no damage to the environment and therefore it will last longer.* (Hazel)

In this definition, Hazel showed a more sophisticated response by appearing to demonstrate an eco-centric attitude by implying in her first sentence that people need to live and interact *with* the environment rather than people controlling it. She also seems to link this attitude with having less environmental impact and this conceptual indicator relates to the environmental component of the researcher's definition. The second component of the researcher's definition included in Hazel's definition is a temporal component when Hazel refers to the way that a lessening of impacts on the environment will cause it to last longer. However, even though Hazel's understanding had broadened she self-rated her definition as *Reasonable* which did identify a shift from *Little*, but is still an under-estimation according to the researcher's rating scale.

Complex				**2**			**Specified future**
Adequate	√			**1**	√	√	**Unspecified future**
Simple				**0**			**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 6.2 Analysis of Hazel's *Good*-rated post-workshop definition

Another example of under-estimation is Alyssa's response. Her post-workshop researcher's rating went from *Good* to *Very Good* and in her initial definition she wrote:

> *It is man's (attempt/activity) to find alternative options to use our resources efficiently and effectively to achieve/last for a lifetime.* (Alyssa)

Alyssa's definition contains two of the researcher's theoretical sustainability components. The first sentence relates to the researcher's theoretical environment component because Alyssa makes reference to the way that people are searching for different ways to use resources in such a way that there is minimal wastage. This statement could indicate her awareness that resources are finite and need to be carefully used. The second component in her definition is reference to a temporal scale when she indicates that people need to find ways to make resources last a lifetime.

> *Sustainability is comprised of 3 dimensions that have huge impacts on each other, they are interdependent. These are economic; environment and social dimensions.*
> *Sustainability is about how best to meet the demand while minimising the impact on all dimensions.* (Alyssa)

Alyssa's post-workshop definition contains two of the researcher's theoretical sustainability components. Firstly, there is mention of the three interrelated components of sustainability: environmental, social and economic, which is one of the researcher's theoretical components. Alyssa also refers to *"meeting demand and minimising the impact"* which could be related to resources. Here Alyssa could be demonstrating her belief that sustainability is like a pair of balance scales where the resources that are needed must be balanced against their impact on the three components of sustainability. This is the second component in her definition and it seemed to relate to the researcher's theoretical environmental component. An analysis of her post-workshop definition is given in Figure 6.3.

Complex				**2**	√		**Specified future**
Adequate	√			**1**			**Unspecified future**
Simple		√	√	**0**		√	**None**
	Environmental Component	**Social Component**	**Economic Component**		**Connections**	**Temporal Scale**	

Figure 6.3 Analysis of Alyssa's *Very Good*-rated post-workshop definition

It appeared that this definition has not increased in its number of components. However, in her post-workshop definition, Alyssa seemed to show her awareness of the interconnectivity of the three components of sustainability (coloured in gold). This awareness is shown by the way that she referred to them being interdependent and impacting on each other. This awareness, together with her two other components could be indicative of a development in her understanding. Nevertheless, despite this evidence of a development in complexity of her

understanding, she self-rated her post-workshop understanding as *Reasonable*, the same rating as she gave her initial definition.

This analysis showed the value of both the theoretical definition and the two analysis tools. Through the use of the theoretical definition's components, the researcher was able to identify developing complexity in the student teachers' understandings of sustainability. The two data analysis tools, the 'researcher's rating scale' and 'definition content analysis tool', allowed the researcher to identify student teachers' growth of awareness of understanding of sustainability. Use of the definition and tools enabled the researcher to then analyse the data in a consistent and rigorous way because she had set criteria to follow and was not dependent upon personal decisions.

In summary, the way in which 16 out of the 21 student teachers reported an increase in their self-rating following the workshops could suggest that they had become more aware of their understanding of sustainability. The growth in their awareness is also shown by the fact 19 of the 21 student teachers' rating positions moved towards the *Very Good* end of the 'researcher's rating scale'. However, 15 out of the 21 student teachers' self-ratings did not correspond with the researcher's rating which suggested that they could have become more aware of the complex nature of the concept of sustainability and because they knew more about it, realised that their understanding needed further development. As a result, they tended to under-estimate it.

Despite their under-estimation, given that 19 out of 21 student teachers' rating positions moved towards the *Very Good* end of the 'researcher's rating scale' which suggests an increase in their awareness of their understanding, that seven student teachers' post-workshop definitions showed an increase in use of conceptual indicators and 16 included more of the researcher's theoretical components in their post-workshop definitions, it would appear that their participation in the workshops did result in most of these student teachers developing a more complex understanding of sustainability.

In both questionnaires the student teachers were asked to identify up to five sustainability issues which can be regarded as another indicator of awareness. The issues identified by the student teachers will be discussed in the next sub-section.

6.4.4 Changes to the sustainability issues identified by the student teachers

Following the workshops, these student teachers were asked to identify up to five sustainability issues. The reason for this question was that being able to identify issues relating to sustainability could indicate an awareness of one's understanding of sustainability and apply it to situations they had encountered. An analysis of their responses showed that not only did these student teachers identify different types of issues, more student teachers were able to contextualise their issues by using a qualifying word or phrase rather than a single word. The researcher decided that this increase in number of issues and types of issues could also be indicative of a growing awareness of sustainability. The data were analysed thematically using the same process described in

Chapter 5 (p. 101) and are presented as multiple response data. These data are presented in Table 6.5.

Firstly, Table 6.5 shows the difference in the total number of issues identified. In the initial questionnaire, the 21 student teachers gave a total of 71 issues, which is just over three issues per student teacher. In the post-workshop questionnaire a total of 100 issues were identified, with everyone providing four or five issues.

Table 6.5 also shows the changes in the types of issues identified. The increase in number of issues identified and the changes could be the result of the workshops raising their awareness of the broad range of sustainability issues. There were large shifts in the categories of *Environmental Degradation*, which went from 2.8% of responses to 11%, and in *Environmental Restoration* which went from 2.8% to 12% (coloured red). The frequency of responses in the *Pollution* category also rose from 2.8% to 6%. There were virtually no changes to the *Energy* or *Resource Depletion* categories. The largest drop in frequency was in the *Unrelated & Non-specific Ideas* category falling from 21.1% to 11% (coloured blue). The frequency of responses in the *Economic Activity* category also dropped from 18.3% to 13% and in the *Climate Change* category from 15.5% to 10%.

Table 6.5 Comparison between the frequency and types of sustainability issues identified by the student teachers in the initial and post-workshop questionnaires

Issue Category	Initial Questionnaire		Post-workshop Questionnaire	
	Frequency *n*=71	**Percentage**	**Frequency *n*=100**	**Percentage**
Energy	14	19.7	19	19
Economic Activity	13	18.3	13	13
Climate Change	11	15.5	10	10
Resource Depletion	11	15.5	15	15
Environmental Degradation	2	2.8	11	11
Environmental Restoration	2	2.8	12	12
Pollution	2	2.8	6	6
Education about Sustainability	1	1.4	2	2
Culture/Traditions			1	1
Unrelated & Non-specific Ideas	15	21.1	11	11

Notes. Red font denotes an increase in number of issues identified.
Blue font denotes a decrease in the number of issues identified.
Black font denotes little or no change in the number of issues identified.

More of these student teachers were able to contextualise the sustainability issues following the workshops. This increase could also indicate a growing awareness of how sustainability impacts their everyday lives. However, it could also have been that these student teachers had more time to complete this item on this particular occasion. In the initial questionnaires four of these student teachers were able to contextualise their issues but in the post-workshop questionnaire, 12 were able to do so. For example, Holly identified two uncontextualised sustainability issues in her initial questionnaire: water bottles which was coded under *Resource Depletion*; and paper rubbish which was categorised as *Environmental Degradation*. In her post-workshop questionnaire she identified five issues. Three of the five were contextualised through the use of a qualifying word or phrase. The first was 'creating bus lanes' which was categorised under *Energy*. Despite the fact that 'creating bus lanes' is a response to the issue of dwindling fossil fuel supplies, it does illustrate that Holly is aware of bus lanes being built to encourage people to use buses and thus reduce fossil fuel use and pollution. The second issue identified was 'environmental education' categorised as *Education about Sustainability* showing that Holly thinks this type of education is important. Holly also identified 'growing vegetable gardens', categorised as *Resource Depletion* and demonstrated that Holly thinks people having vegetable gardens is a way of reducing a household's dependency upon commercially grown crops. She might also think that this activity could re-connect people with food production processes. Her final two issues were composting, also categorised as *Resource Depletion* and deforestation which was coded as *Environmental Degradation*. In this way Holly seems to show a deeper understanding of sustainability which could relate to her post-workshop understanding rating of *Very Good*.

In summary, the increase in the number and types of issues identified by these student teachers appeared to indicate an increase in their awareness of sustainability issues in their everyday life. This increase could also indicate that their understanding of sustainability was deepening. An increased awareness was also illustrated by the way that more of the student teachers were able to contextualise their issues.

When designing professional workshops, it is important to find out what activities teachers perceive to be the most effective in changing their ideas. The student teachers were asked to identify which activity they thought was the most effective in developing their understandings of sustainability. These findings will be presented in the next sub-section.

6.4.5 Student teachers' identification of the most effective activity

During the peer interviews, these student teachers asked each other what activity they thought had the most impact on their understanding and why. This question was included because knowing what activity was most effective could give an insight into their perceptions about pedagogy and their understandings of sustainability. Self-perceptions of their pedagogy and their understandings are related to their identity as an EfS teacher.

There were 27 responses, resulting in the presentation of multiple response data. Nine of the student teachers' responses (33.3%) identified the consequence wheel activity (Appendix G) as

the most effective. The second most effective activity was the jigsaw (Appendix E) with eight responses (29.6%). Next was the picture sorting activity (Appendix C) with five responses (18.5%). The diamond ranking activity (Appendix H) received three responses (11.1%) and the researcher's presentation about sustainability (Appendix D) two responses (7.4%).

The reasons given for their choice of activity were coded into categories by the researcher and verified by a colleague. Thirty-two reasons were given for the student teachers' choices of most effective activity. Interestingly, the majority of the reasons given related to their learning, with only four responses (12.5%) relating to the activity's suitability for teaching. The reasons given for the effectiveness of the consequence wheel related to it encouraging the student teachers to think (6 responses or 18.8% of the total responses) and it being suitable for teaching (3 responses or 9.4%). An example of a response categorised as encouraging thinking was from Ivy:

> *… I had to seriously think through what affected what from the most to the least and that sort of evokes thinking that I didn't have before.* (Ivy)

The reason for including the consequence wheel was to foster student teachers' critical thinking about their ideas about rubbish disposal and to encourage them to think of alternative perspectives (Mezirow, 1990). Through this consideration of alternative perspectives, it was hoped that student teachers would change their ideas about sustainability so that their understanding would become more complex. Ivy's comment about having to "seriously think" during this activity and when she said that it made her think in a different way, this is suggestive of her thinking critically. Holly also identified the consequence wheel as the most effective activity:

> *… that made me think of the broader solutions that come from implementing smaller things …* (Holly)

Like Ivy, Holly's comment suggested that she was thinking critically because this activity required her to think about the effects of actions beyond the classroom, visualise future outcomes and then the possible effects of them.

Although Lily also identified that the consequence wheel activity fostered thinking about effects of one's actions, she was able to relate this activity to her future classroom pedagogy. Her reason was categorised as a *Suitable for Teaching* response:

> *… starting with thinking about something quite small and how that kind of gets bigger and how that impacts … I would definitely use that in my classroom with kids to think about … what you're doing now will have consequences and what you're doing in terms of your actions have consequences looking at sustainability …* (Lily)

Like Holly, Lily saw this activity as starting with something small and thinking more widely about the impacts of one's actions. Also, Lily identified that this activity would foster critical thinking but she saw this as thinking that children would do and did not seem to relate such thinking to herself.

The jigsaw puzzle activity was identified as the next most effective activity and the reasons given for its effectiveness were that it illustrated the three interrelated components of sustainability (4 responses or 12.5%); encouraged thinking (3 responses or 9.4%) and was suitable for teaching (1 response or 3.1%). Fleur's response is indicative of the responses related to it illustrating the interrelated components when she said:

> … *I liked the way it was set out, how the environment was set out around the edge. You could see everything link into each other and you could see the environment link into everything so it shows that the environment was the most important.* (Fleur)

The jigsaw activity was designed to encourage thinking about the interrelationship of the three sustainability components. By seeing the interrelationship, it was hoped that this visual representation would challenge their existing ideas and then provide an opportunity for thinking about alternative perspectives which could lead to a change in their ideas about sustainability (Mezirow, 1990). Fleur's comment seemed to show that she thought the visual layout of the jigsaw helped to develop her ideas about the interrelationship of the components of sustainability and the importance of the environmental component, ideas that she did not have at the start of the workshops.

Iris's comment is an example of a response about the jigsaw encouraging thinking:

> … *'cause it got me to think about how important the environment is …* (Iris)

In this response, Iris seemed to indicate that the jigsaw activity made her think critically about the importance of the environmental component, possibly resulting in development of her ideas. This transformation could have occurred because the jigsaw puzzle depicted the social (including cultural) and economic components in the middle and the border as the environmental component. This positioning privileged the environmental component in a manner similar to that of the model of strong sustainability shown on p. 21.

Only one category of responses was given for the effectiveness of the picture sorting activity and that was it encouraged thinking (4 responses or 12.5%). An example of such a response was Petunia's:

> … *because it made me think deeper about what was sustainable.* (Petunia)

The re-sort of the picture cards took place following the researcher's presentation about sustainability. During this presentation, these student teachers were exposed to new ideas about sustainability which could have resulted in conflict with their current ideas. When the student teachers reflected on the way they had sorted the picture cards before the presentation, their ideas might have changed as a result of the presentation, leading them to re-consider their groupings. Petunia's comment seemed to indicate that she did think critically about sustainability which might have led to the development of her ideas about this concept.

Some of the student teachers could not identify just one activity as being effective and gave reasons as to why all of the activities were important. Such reasons included the value of hands-on activities (3 responses or 9.4%), the value of using visual activities (2 responses or 6.3%) and the opportunity to look at others' ideas and discuss them (2 responses or 6.3%). Daisy's response is an example of the value of discussion and looking at others' ideas:

> *… especially when I was finished with my activity, just looking at what other people had done and discussing why we'd done it that way and then once we'd finished the activities just talking about the things that they were about just helped me to understand sustainability a bit more.* (Daisy)

Daisy's comment about discussion could relate to the opportunities given for rational discourse during the workshops. Such discourse or discussion gave student teachers the opportunity to think about others' ideas, to critically reflect on their own ideas in relation to others' ideas and this process could have assisted in the development of their ideas about sustainability (Mezirow, 2003).

Jasmine also commented on the value of engaging in rational discourse with others:

> *… but it wasn't just doing the activity. It was going round and looking at everybody else's ideas and talking to them about how they looked at it as well so their perceptions. I actually learnt probably more hearing other people's perceptions than I did just doing the activity.* (Jasmine)

Jasmine's statement illustrates the value she placed on discussion and in particular, listening to others' perceptions. This statement could be evidence of Jasmine assessing others' beliefs, arriving at a judgement about their ideas about sustainability and critically reflecting on her own ideas in relation to others'. The process might have led to her changing her ideas.

An example of a response where the use of practical activities was valued was Clover's. She talked about the use of hands-on activities and visual material:

> *I really enjoyed … organising the pictures into the diamond shapes and the big jigsaw is quite important as it's a visual aid … personally for me I enjoy practical activities so this really helped …* (Clover)

Clover's comment appeared to show her preference for manipulating concrete materials. It could be that the manipulation of materials helped her to think critically in order to resolve any conflict between her existing ideas and new ideas presented during the workshop, possibly leading to the expansion of her ideas about sustainability.

In summary, these student teachers thought that this range of activities had impacted on their understanding. The commonly expressed reason for the effectiveness of activities was that they encouraged thinking or in terms of transformative learning theory, fostered critical thinking. Comments about the activities such as it made them think "deeper" or "seriously think", suggested that they were thinking about their existing ideas about sustainability, considering alternative

perspectives and possibly transforming their ideas. In this way these comments reveal that learning could have been taking place. Changing one's ideas could relate to identity change because as a person's ideas change, they perceive themselves in a different way.

Other reasons given for the effectiveness of activities related to pedagogy. Those student teachers who commented on the value of discussion or rational discourse, visual activities and hands-on activities seemed to be showing their preference for learning in this manner. Preference for a particular way of learning is also related to identity because it could influence the types of activities a teacher chooses to use in their classroom programmes.

In these ways the student teachers' choices of activity and reasons given for its effectiveness seemed to reveal their learning and pedagogy, both of which could be related to their identity as teachers of EfS.

During the peer interviews student teachers also asked each other what was the most important concept that they had learnt during the workshops. These results will be presented in the next section.

6.5 Identification of most important concept learnt during workshops

Student teachers used peer interviews to identify the most important concept that they had learnt. Even though they were only asked to identify one thing, 25 responses were given. These responses were analysed thematically.

Two categories were developed during analysis: *Effects of People's Actions* (11 responses or 44%) and *Knowledge/Understanding* (10 responses or 40%). The remaining four responses were not able to be categorised and related to ideas such as weighing up options; taking personal responsibility, knowing the difference between want and need and classroom resource use.

In the *Effects of People's Actions* category, six of these student teachers said that the way in which people's decisions and actions have impacts on the environment was the most important concept that they had learnt. Posy's response is an example:

> *… the whole concept of the social and economic things impacting on the environment and like it's not just the things like recycling … it's everything that impacts on the environment and just being aware of that and trying to make positive changes.* (Posy)

In her response, Posy seemed to have moved away from thinking that recycling was important and instead, demonstrated the belief that all things have an environmental impact, including social and economic components. She stated that people need to be aware of their impact and work towards making changes that would lessen their impacts as the most important concept she had learnt.

Three of these student teachers' responses in this category related to an awareness of future impacts on the environment being the most important. Poppy said:

> *The consequences, if we don't look at sustainability and doing things for our environment, like the future impacts it's going to have.* (Poppy)

In this statement Poppy appeared to identify that the consequences of actions today impacting on the future was the most important conceptthat she learnt but did not specify what such consequences might be.

The last two responses in this category, *Effects of People's Actions*, student teachers said that the most important concept they had learnt was that people's actions can make a difference. Holly is an example of this type of response:

> *… how we can action things to make our world more sustainable.* (Holly)

Holly's response showed her belief that people can take actions to make the world more sustainable was the most important concept and could imply that she could be considering taking actions to do so.

The other category entitled *Knowledge/Understanding* had 10 responses. All of the responses in this category related to learning about the interrelationship between the three sustainability components being the most important concept learnt. For example, Ivy said:

> *… that there was a social, economic and environmental model about sustainability and how they fitted together.* (Ivy)

Rowan's response was similar:

> *... you need to consider the cultural aspects of lifestyle, the cultural, the social, the economic and the environmental, and how they're interrelated. And if one changes, it affects basically all of the rest of them.* (Rowan)

In the peer interviews, the student teachers also asked each other how their participation in the workshops might affect their future teaching pedagogy. These results will be presented in the next section.

6.6 Effects of the workshops on the student teachers' future pedagogy

Another peer interview question was asking their partner how they thought participating in these workshops would impact on their future pedagogy. As before, the student teachers' responses were thematically analysed. As 40 responses were given, it was deemed multiple response data.

There were three categories of responses: *Classroom Resource Management*; *Intent to Teach Sustainability*; and *Philosophical Reasons*. Over half of responses were categorised as *Classroom Resource Management* with 23 responses (57.5%). Eleven (27.5%) of the responses related to the *Intent to Teach Sustainability*, while six (15%) were categorised as *Philosphical Reasons*.

Responses that were categorised as *Classroom Resource Management* related to ideas such as implementing recycling systems in the classroom, setting up composting and/or worm farming systems, planting vegetable gardens at the school and reducing energy usage. One example of this type of response was Iris who said:

> *It will encourage me to get involved with school recycling, vegetable gardens, having worm farms …* (Iris)

Rose's response was similar and she stated:

> *I would like to think that it would have a large impact on my teaching. I would like to introduce it [sustainability] into my classroom and I'm sure I will especially in terms of recycling, reducing and reusing, also just simple things like always turning off the lights. I would like to have a vegetable garden as well.* (Rose)

While these ideas of waste minimisation and reduction of energy use would provide good role modelling for the children, they do not encourage children to think about the need or reason for carrying out these practices. In terms of EfS pedagogy, the reasons for these practices need to be critically considered in conjunction with the teaching of the concept of sustainability (Tilbury, 1995).

The next largest category of responses was *Intent to Teach Sustainability* and responses that incorporated ideas about intending to include sustainability in their classroom programmes or knowing how to teach it if required were included here. An example of such a response was Marigold's:

> *… I'd be able to teach it now from what I've learnt and I'd be able to implement ideas into the classroom and school environment.* (Marigold)

Daisy's response was similar:

> *I think my understanding of sustainability will impact on my teaching quite a bit now that I know a bit about sustainability … I'd like to learn more about it but I definitely want to incorporate sustainable programmes into my classroom.* (Daisy)

The smallest category, *Philosophical Reasons*, related to ideas such as wanting to build sustainability into the classroom culture, being a catalyst for change by educating about sustainability and the impact of personal beliefs about sustainability on children in a teacher's classroom. An example of this type of response was Briar's:

> *I think it's [sustainability] going to be just a part of what my class does. It's about training your class and that's just what you do and I think if you can train your class to be able to do that [implement sustainable practices], then that should carry on into all aspects of their life, and especially into their next class and their classes in the future to educate more people. It's like the domino effect really, one, then another, then another, so hopefully I can be a catalyst in that creation.* (Briar)

Briar's comments seemed to reveal her pedagogical philosophy that in her role as a teacher, she would be able to bring about change when she referred to herself as a "catalyst". Her statement showed that she believed that by making sustainability part of her classroom culture, it would bring about change in her children's practices that will carry into their future classes and all aspects of their lives.

In the final interview, the student teachers were asked if participating in the workshops had affected any of their lifestyle choices and these results will be presented in the next section.

6.7 Changes to the student teachers' lifestyle choices

During the final interview with the researcher, each student teacher was asked if their participation in the workshops had affected any lifestyle choices that they made. This question was included because of the premise that what teachers do in their lives outside of their schools might affect their pedagogy. Therefore, making lifestyle choices that are related to sustainability could affect teachers' pedagogy.

Thirteen out of the 21 student teachers reported making changes to their lifestyle choices that were related to sustainability. Seven of this group of 13 student teachers said that they already incorporated sustainable practices such as recycling and energy saving into their lifestyles and since their participation, had further increased their sustainable practices. Four other student teachers said that they already incorporated sustainable practices but had not made any further changes since the workshops. The remaining four student teachers discussed the way that they had become more aware of sustainable lifestyle practices but had not made any changes.

Pansy was an example of a student teacher who decided to make sustainable changes to her lifestyle. She decided to take organic waste out to her parents' place for their chickens, had begun recycling at her rented house and had purchased a worm farm for her brother's birthday present. She said:

> *I've started like 'cause we don't have chickens at our house but my parents have like chickens and stuff so I've started, like I've got a scrap bucket now and so I take all of my scraps out there, whereas just before they would go into the bin with everything else. And recycling, our landlord didn't have any recycling things, so started doing that, and they haven't got us buckets but I put it in a plastic bag and I take it to my parents and I put it in their recycling baskets. And we got a worm farm for my brother for his birthday, so we trying to make a change I guess. (Pansy)*

Posy was an example of a student teacher who had already incorporated sustainable practices into her lifestyle choices but, as a result of the workshops, decided to do more:

> *I try and be as energy efficient and always switch everything off … in primary school we were all quite really hyper on recycling … and it's sort of stuck with me so I've always been into saving power and things like that. Now I'm moving into the country …my boyfriend's got a veggie garden and … I've been talking to him [my boyfriend] about getting his dad a worm farm for Christmas … so I do the whole compost and worm farm thing.* (Posy)

This section has explored the changes that these student teachers made to their lifestyle choices outside of teaching because it was hoped that such choices could impact on their pedagogy. The next section will bring these results along with all of the data gathered from each student teacher together in order to explore the effects of the workshops on their identities as education for sustainability teachers.

6.8 Effects on the student teachers' identities as education for sustainability teachers

Investigating teachers' professional identity is important because their experiences and sense of self have a strong influence on their development as a teacher and on their pedagogy (Clandinin & Connelly, 1995). In order to analyse this group of student teachers' identities, the researcher developed a set of categories and then, through an analysis of the data, classified these student teachers into four categorisations of identity in relation to EfS. Firstly, the way in which the categories were developed will be described. Then the results will be presented along with examples of each category.

6.8.1 Development of the 'identity characterisation tool'

A tool containing four categories was developed in order to analyse the student teachers' identity related to their teaching of EfS. It is important to take into account that the development of the categories was based on the researcher's values, ideas and interpretation of the data (Sarantakos, 2005). The researcher decided to develop criteria for each category that were based on the data that had been generated and in this way the tool provided a snapshot of their developing identity in terms of being a teacher of EfS. The resulting analysis tool is a characterisation that shows differing categories of identity and the categories were entitled *Naïve; Emergent; Developing* and *Complex* and shown in Table 6.6. It was decided to take into account a range of data that included: the post-workshop sustainability definition and rating position; the sustainability issues that were identified; an intent to incorporate sustainability teaching into future pedagogy; intent to develop resource management systems into future pedagogy, such as recycling; incorporation of sustainable practices into lifestyle choices both before and after the workshops; and philosophical ideas expressed during the interviews that related to the bringing together of the student teacher's personal beliefs and their beliefs about teaching.

The researcher decided to focus on these six aspects because of their relationship to a person's identity. Because the researcher based decisions on aspects of identity theory and theory related to the relationship between knowledge and action, this characterisation was developed deductively (Braun & Clarke, 2006). For example, what a person knows about an issue such as sustainability can affect their actions, so it was important to take into account the student teachers' understanding of sustainability and their ability to identify sustainability issues (Kollmuss & Agyeman, 2002). Because of the relationship between knowledge and action, the student teachers' actions in terms of intent to teach about sustainability, to implement resource management systems like recycling in their classrooms and their decisions to incorporate

sustainable practices into their lifestyle also needed to be considered (Birdsall, 2010; Jensen, 2002). The last aspect, philosophical ideas, was considered important because the researcher proposed that the bringing together of personal ideas about sustainability and ideas about teaching was indicative of a student teacher who would infuse sustainability into their pedagogy as well as encouraging sustainable practices such as recycling in the classroom (Beijaard et al., 2004).

Table 6.6 Categorisations of identity in relation to EfS teaching and their associated criteria

Types of Data Included	Naïve Category	Emergent Category	Developing Category	Complex Category
Definition Rating	Good	Good/Very Good	Very Good	Very Good/Very Good Plus
Sustainability Issue Identification	No context for issues given	1-2 issues contextualised	2-3 issues contextualised	3 or more issues contextualised
Intent to teach sustainability	Teach sustainability if have to	Teach sustainability	Teach sustainability	Teach sustainability in integrated way
	Or	**Or**	**And**	**And**
	Thinking about resource systems	Implement resource systems	Implement resource systems	Implement resource systems
Incorporating sustainable practices	Thinking about incorporating	Made 1-2 changes or already incorporating	Made 1-2 changes and already incorporating	Made more than 2 changes and already incorporating
Philosophical Ideas	None expressed	None expressed	Personal ideas about sustainability impacting on pedagogy	Incorporation of sustainability into classroom culture as part of teaching philosophy

The criteria for each category were used to place each student teacher but they did not always fit neatly into a particular category. In such instances, the researcher thought about each case and placed the student teacher on a best fit basis. Based on the criteria, the student teachers were placed in a category that began at *Naïve,* representing a student teacher that did not seem to have a particularly good understanding of sustainability, had thought about incorporating sustainable practices into their lifestyle but not actually done so and did not appear to think it would be an important part of their classroom programme. The highest category, namely *Complex*, was representative of a teacher with a sophisticated understanding of sustainability, having already established sustainable practices and thought about doing more and regarded sustainability as an integral part of their classroom programme and culture.

6.8.2 Student teachers' identities as EfS teachers

Using these criteria in Table 6.6, it was found that four of the student teachers were placed in the *Naïve* category, eight in the *Emergent* category and nine in the *Developing* category. These data are shown in Table 6.7.

Table 6.7 Student teachers' placement in identity category using the identity characterisation tool

Identity Category			
Naïve Category	**Emergent Category**	**Developing Category**	**Complex Category**
Ivy, Pansy, Petunia, Willow	Clover, Daisy, Fleur, Hazel, Holly, Jasmine, Posy, Rowan	Alyssa, Briar, Fern, Iris, Lily, Marigold, Poppy, Rose, Violet	

No student teachers were placed in the *Complex* category because none met the criteria for this category. The reason why none met the criteria was that although these student teachers had talked about their intentions to teach about sustainability, they have yet to realise their intentions and actually teach an EfS programme.

An example of a student teacher who was placed in the *Naïve* category was Willow. During the course of the workshops her rating position on the researcher's scale of understanding shifted from *Little* to Very *Good* and she wrote that:

> *Sustainability includes the economic, cultural and environmental factors that influence how our world can continue.* (Willow)

Willow's definition included the three interrelated sustainability components and a temporal scale. Despite this shift in her understanding rating, her five sustainability issues were not contextualised with sufficient detail:

> *Fuels, forests, recycling, technology, cultural practices, i.e. fisheries*(Willow)

Even though it appeared that Willow had contextualised the last issue, that of cultural practices in terms of fisheries, it was not clear to which cultural practices she was referring. For example Maori people have very different fishing practices to European people and due to this lack of clarity, the researcher deemed this issue to be ill-defined.

When asked about how her understanding of sustainability would impact on her teaching, Willow thought that it had made her more aware of recycling but never mentioned that she would be implementing a recycling system:

> *I think it just makes me more aware … in my classroom about recycling to be honest.* (Willow)

Willow thought that the workshops would have an effect on her life in the future but did not talk about any changes to her lifestyle choices that she had already made before the course. Instead Willow said:

> *Having done just this little time with you I think it makes me think about things a lot differently. … I mentioned that we have a pool and we didn't put solar heating in. We put electricity in. I mean how stupid is that but I wouldn't have thought about that before. As it is it's a freezing cold pool because we never put the heating on but those sorts of things will affect my future … so yes the course will affect my future experiences.* (Willow)

This statement showed that Willow intended to re-consider her lifestyle practices as a result of attending the workshops. It also showed that she was able to look back at past actions, that is the decision to use electricity to heat their pool, and realise that they should have chosen to use a renewable power source like solar energy.

An example of a student teacher who was placed in the *Emergent* category was Clover. Her post-workshop understanding of sustainability was rated as *Good* and she wrote that sustainability meant:

> *Using natural resources to preserve and conserve the environment. Being aware of the impact of unsustainable resources on the nature environment.* (Clover)

The first conceptual indicator in Clover's response was categorised as *Resources* and the second *Caring for the Environment*. Clover identified five sustainability issues, one of which was contextualised, stating:

> *Deforestation = no habitat for animals; water conservation; recycling - reduce, reuse, recycle; conserving wildlife; and solar energy – sun panels.* (Clover)

When asked about the workshops' impact on her teaching, Clover thought that she would be able to bring the activities from the workshops into her class and she commented about the value of the workshops being:

> *… actually having resources that we can use in the classroom next year.* (Clover)

While Clover never mentioned incorporating sustainability into her classroom programme, she appeared to be enthusiastic about being part of an environmental group at a school but not a leader:

> *I'd really like to be part of whatever the school system has for the kind of a nature group or an environmental group, getting in part of that …* (Clover)

Although Clover never identified any changes she was making to her lifestyle choices, she did identify already established practices:

> *We actually have energy saving bulbs at home. We have a compost bin at home … and we try and reduce our petrol costs, so we try and walk if we just need to go down the road*

> *to the shops or something … there's a lot of things that I'm aware of that I can have a more sustainable life …* (Clover)

Clover's last comment in her final interview illustrates the way that she seemed to be developing a personal awareness of sustainability in her everyday life but had not extended this awareness into her pedagogy. She commented:

> *I think it's [the workshops] opened my eyes to a lot of the issues in society and how I can, as an individual, make an impact on the environment and make it a more healthy environment*. (Clover)

Finally, an example of a student teacher who was placed in the *Developing* category was Lily. Her post-workshop definition was rated as *Good* and she wrote that sustainability meant:

> *Actively maintaining and improving what we have (the world) so future generations can experience and enjoy it too.* (Lily)

This definition was categorised as *Intergenerational Equity* because of its reference to future generations having what people have today. Like the other two student teachers, Lily identified five sustainability issues and contextualised two:

> *Caring for the environment; protecting what we have (animals, etc.); recycling; deforestation; renewable energy.* (Lily)

Lily thought that her participation in the workshops would impact on her teaching. Although she did not directly state that she would be teaching sustainability programmes or incorporating resource management systems like recycling and composting in her classroom, it was stated implicitly when she said:

> *… in a classroom that's kind of what I would be looking at … our responsibility to look after what we've got, whether that be turning off a light for power, making sure our gardens are well looked after, veggie gardens, worm farms, whatever, making sure that the things we do, realising the impact or minimising the impact or making sure that it's a positive impact on things …* (Lily)

While Lily did not identify any existing sustainable practices, she spoke about implementing some into her lifestyle choices and consequently affecting the lifestyle of her family. Lily became more conscious about the packaging of food products that she purchased, decided to reduce her consumption of fossil fuels and got some chickens. She said:

> *We have made quite a few changes in the way that we do things … like I bought little tubs for my kids' lunchboxes to put things in so we're not doing the whole crisps and all that … and I can buy one big box of the Shapes crackers and we divide it up … so we've not got the rubbish and stuff … we've now got chickens running round in my back garden … hopefully giving us eggs … I've got myself a scooter as opposed to having a second car so that my husband can take the children to and from school but also as well … they're going to walk at least twice a week as opposed to going in the car …* (Lily)

During her final interview, Lily's ideas appeared to show that not only had she developed a personal awareness of sustainability in her life outside of school, she also intended to incorporate it into her future pedagogy. Evidence of this can be seen in this comment when Lily said:

> … *figuring out all the cool stuff I can do with the kids when I get out that actually is going to put them towards having a sustainable life and environment.* (Lily)

Furthermore, Lily's ideas seemed to illustrate that she now felt a sense of guardianship for the area in which she lives and felt a responsibility to care for the environment for future generations, which corresponded with her post-workshop definition of sustainability. She also seemed to believe that her personal beliefs would impact on her teaching and saw herself as a role model for others. These ideas can be seen when Lily stated:

> *Well I want stuff to be there for them when they're older and when they've got kids and things … we do really need to look after what we've got … my place in the world is where I have an effect, where I can change things and I can ensure things are kept and so by looking at my place and my effect, taking responsibility for my things, therefore demonstrating to my children and those around me that I need to be responsible for the things that I have control over. … I think that the way that the sustainability classes have made me think, my ideas have changed and will automatically come out in my teaching because you kind of teach what you know and what you believe in … always when you're teaching, your own viewpoints are going to come out no matter what …* (Lily)

Lily's statement illustrates the way that her personal beliefs about sustainability have impacted on her teaching beliefs.

In summary, this analysis showed that this group of student teachers had a wide range of ideas about sustainability, its pedagogy and their intentions to include this concept in their future pedagogy that impacted on their identities as teachers of EfS. The identity characterisation tool enabled the researcher to show the different categories of identity within this group of student teachers because of the criteria developed for each category.

6.9 Chapter summary

This chapter has presented the findings of the second and fifth research questions. The second research question of how can student teachers' understandings of sustainability be developed, focused on the effects of the workshops on student teachers' understandings. These workshops did effect a change in their understandings which was measured using a count of conceptual indicators and theoretical components used in their defintions, as well as the use of the 'researcher's rating scale' and the 'definition content analysis tool'. Additionally, these student teachers were able to identify more sustainability issues and 12 were able to contextualise some of their issues.

Student teachers identified three activities that were particularly effective in developing their understandings of sustainability: the consequence wheel, the jigsaw activity and the picture sorting activity because they encouraged critical thinking. They also regarded the discussions, or rational discourse, that took place to be of value, along with the visual and hands-on activities.

This chapter also explored the fifth research question: How does their understanding of sustainability affect these student teachers' sense of identity as EfS teachers? Data were analysed with a tool that had been developed by the researcher that consisted of four categories and described on p. 136. Four categories of identity formation were developed: *Naïve, Emergent, Developing* and *Complex*.

The development of these student teachers' understandings of sustainability appeared to have an effect on their identities as teachers of EfS. This effect could be seen by the way that these student teachers indicated that they intended to include sustainability in their future pedagogy. A few went further and said that they intended to make it part of their classroom culture and saw themselves as catalysts of change through their future teaching of EfS programmes.

The definition, tools and identity characterisation tool will now be used in the next chapter which presents the findings about two practising teachers' understandings about sustainability, their identities as EfS teachers, the ways in which they translated their understandings into their pedagogy and its effects on their children's learning.

Chapter 7: Developing Pedagogical Context Knowledge in Education for Sustainability Teaching

7.1 Introduction

This chapter presents data from two practising teachers: their understandings of sustainability and their translation of their understanding of sustainability into their pedagogy. It traces the effects of this pedagogy on their classes of children's learning as well as the effects of their understanding of sustainability on their identities as EfS teachers. These practising teachers, Hamish and Mike, participated in a series of workshops containing the same activities as the student teachers' workshops described in Chapter 4 on pp. 67-8. Following the workshops, they both planned and taught an EfS programme. Semi-structured interviews provided data about their teaching and EfS programmes. Three such interviews were conducted with Brian and five with Mike. Once the programme was completed, the researcher interviewed children individually from their classes about their understandings of sustainability. Finally, the researcher interviewed Hamish and Mike individually once they had finished their teaching to gather data about changes to their identity as EfS teachers.

Two interpretivist stories are presented in this chapter, one about Hamish and then the other about Mike. These interpretivist stories have been constructed from the data generated in the interviews mentioned above. Data about the development of Hamish and Mike's understandings of sustainability using the analysis tools that were described in Chapter 5 have also been included. The data gathered about their children's understandings of sustainability are included and were analysed in three ways. These were: children's ability to explain the interrelationships that they were taught; their ability to state the definition taught to them and their ability to give an example of sustainability. Each story concludes with an analysis of these two teachers' identity using the identity characterisation tool described on p. 136.

7.1.1 Chapter structure

Section 7.2 presents a description of Seaview School where both Hamish and Mike work. Hamish's story is presented in Section 7.3 and Mike's in Section 7.4. Both interpretivist stories include descriptions of Hamish and Mike's teacherly personas; the effects of the workshops on their understandings and awareness of sustainability; their choice of topic and an analysis of their planning for its teaching; how they introduced sustainability to their children and teaching strategies used during the programme; reflections on their teaching; effects on their children's learning and an analysis of their identities as EfS teachers.

7.2 Description of Seaview School

Seaview School is located in the central Auckland suburbs. It is a Year 1 to 6 school catering for children aged from 5 to 11 years old. It has 28 teachers and five of those teachers are males. Seaview has a decile rating of five[1]. This school has a roll of approximately 550 children from a variety of ethnic backgrounds. The ethnic composition of the children who attend Seaview is shown in Table 7.1.

Table 7.1 Ethnic composition of children attending Seaview School

Ethnicity	Percentage of Students (%)
New Zealand European/Pakeha	24
Maori	8
Indian	26
Samoan	9
Chinese	7
Tongan	6
Other Asian	6
African/Middle Eastern	7
Niuean	3
Cook Island	3
Other Pacific	1

Note. Data sourced from Education Review Office (n.d.)

According to Hamish's comments, Seaview's Principal is supportive of EfS programmes and it has a curriculum team of teachers from throughout the various levels of the school working to infuse EfS into the school's programmes.

Some years ago, Hamish had some EfS professional development while working at another school. However, at present there is no professional development available except for local council run courses, and according to Mike this team is not finding their task of infusing EfS programmes into the school easy.

The Principal's support for EfS is also illustrated by the way that Seaview is involved in two local council funded environmental initiatives, WasteWise Schools and TravelWise. WasteWise Schools is an EfS programme run by Auckland Council with the aim of empowering schools to reduce their waste (Auckland Regional Council [ARC], nd). The council provides the school with

[1] The Ministry of Education's ranking system based on the socio-economic rating of the school's community and the school's predicted potential to access community resources and support.

the latest waste reduction practices with an anticipation that the children will transfer these skills into their home lives. WasteWise programmes support aspects of *The New Zealand Curriculum* (MoE, 2007) such as learning about the science of composting and worm farming. The philosophy is based on it being driven by students within the school and requires the whole school to be involved. Both technical and educational support is provided by the Council (ARC). Seaview has completed this programme and have been awarded their certificate.

TravelWise is a programme designed to address the problem of traffic congestion around school gates before and after school (Auckland Transport, 2011). Its aim is to reduce the number of people bringing cars to schools to drop off and pick up children and encourage safe and sustainable transport choices such as walking, cycling, car pooling and public transport. TravelWise offers two programmes, a School Travel Plan and the Walking School Bus (Auckland Transport). Seaview's travel plan includes having parents parking their cars in a nearby side street as well as a traffic engineering solution to avoid congestion outside the school's front gate. A walking school bus is also operated where children are collected from stops along the way to school and escorted by volunteers walking to and from school.

There is further evidence of the Principal's support for sustainability in that the school has 13 raised bed gardens that are maintained by allocated classes. The teachers are encouraged to plant out these beds with vegetables and herbs and share the produce with the children. These gardens are also used as a teaching resource. For example, Hamish reported using the gardens to show children how bees pollinate flowers to make fruit. Seaview also has an orchard but this is the responsibility of a group of parents. It contains fruit trees such as feijoas, tamarillos, passionfruit, bananas and guavas along with seasonal vegetables. Teachers use it as a resource when appropriate and the children get to eat the fruits and vegetables as they are harvested.

Finally, Seaview has food for sale through a school tuck shop where staff and children can order food for snacks and lunches. It is staffed by parents and sells home-made food with an emphasis on healthy eating. Therefore, in these ways, the teachers of Seaview School have a context supportive of EfS if they choose to implement such a focus in their teaching.

The next section tells the story of Hamish, an older teacher who works at Seaview School teaching a Year 3 class (7-8 year old children).

7.3 Hamish's story – the nurturer

This section is about Hamish. It begins with a brief description of his life. Section 7.3.2 presents how Hamish sees as himself as a teacher, which this thesis proposes is related to his professional identity. In Section 7.3.3, the development of his understanding and awareness of sustainability is discussed. His choice of topic in which to teach sustainability is presented in Section 7.3.4 and his planning analysed in Section 7.3.5. The way in which Hamish introduced sustainability into his classroom programme is presented in Section 7.3.6. In Section 7.3.7, the teaching approaches

used to develop the children's understanding of sustainability are discussed and Hamish's reflections on his teaching presented in Section 7.3.8. The effects of his teaching on the children's understandings of sustainability are discussed in Section 7.3.9 and this section concludes with an analysis of Hamish's identity as an EfS teacher in Section 7.3.10.

7.3.1 Hamish: Professional and personal

Consideration of a teacher's personal life is important when studying their pedagogy because aspects of a teacher's personal life intersect with their professional life (Clandinin & Connelly, 1995) and provide part of a teacher's identity. This researcher takes the position that a teacher's personal life is also important when researching their EfS pedagogy because a person's childhood experiences of nature and the influence of mentors and role models are regarded as "key entry-level variables" that affect people's interest in nature and subsequent decisions to take action to protect the environment (Chawla & Cushing, 2007, p. 440).

When talking about his childhood, Hamish recalled watching and helping his father in the garden. He grew up on a property with a large vegetable garden, containing fruit trees and utilising a composting system. His mother bottled fruit and tomatoes and made jam. Gardening seemed to have had a significant effect on his life because when he went flatting in his late teens, the first thing he did was plant a garden.

His affinity for gardening continued and after completing a degree in sociology and travelling overseas, he moved into a community in a remote part of New Zealand. While living there with his family he was involved in subsistence farming that included sheep, pigs and cows and an apricot orchard. He moved from the community into a small town when his eldest daughter began secondary school in order to cut down on her time travelling on a metalled road to school.

While living in town, Hamish used his lead-lighting skills to be employed by a window glass company. He became interested in teaching after spending time at the local school glazing. In his late forties he went on to complete a Graduate Diploma of Teaching.

The family then moved to a large New Zealand city where his wife took up a position in a government department and Hamish was the caregiver for their children. Hamish has worked as a teacher for twelve years, the first two at a lower decile school and the remainder at a high decile primary school, teaching Years 4, 5 and 6. At the high decile school Hamish was responsible for the gifted and talented programme and was also involved with Enviroschools. He helped the school gain a Bronze and Silver Award. These awards were given to the school for setting up a recycling system, a worm farm and gardens.

When Hamish moved to Auckland and gained the position at Seaview, he was put in charge of the school's environmental education curriculum team. He also oversees the school's gardens, offering advice to other teachers when required.

Throughout this account, Hamish presents himself as a nurturer, firstly of the land with his gardening and farming, of his family as the caregiver and now as a teacher. He has been able to combine his nurturing of the land with his teaching career by taking charge of Seaview's gardens. In the next sub-section, Hamish's teacherly persona is presented.

7.3.2 Perceptions of self as a teacher

The teacherly persona is important because it combines identity with Barnett and Hodson's (2001) elements of pedagogical context knowledge (PCxK), which include knowledge about how children learn. Hamish's perceptions of himself as a teacher showed his awareness of his age and his nurturing personality:

> *I'm an older teacher compared to a lot of the younger ones so I almost feel like a father figure to some of the kids … or a grandfather figure, so I'm kind of shepherding them through a year …* (Hamish)

This comment showed the way that Hamish regarded himself in a nurturing role in relation to the children because he referred to himself as a "father", "grandfather" and that he shepherded them through the year in his class. He also acknowledged that he was older than many of the teachers at the school and it could be that he felt he was a father figure to the younger teachers as well.

Hamish also made reference to being a male in a female-dominated profession:

> *I like to get outside and play lots of games with them so it's probably because I'm a man … the other teachers say oh, I didn't have time for PE today or I didn't have time for fitness and it's just something that I always do and I always like to get the kids up and out and doing things.* (Hamish)

Sports and physical activity are traditionally associated with males and it could be that Hamish saw physical activity as important because it was a point of difference between himself and his female colleagues.

Hamish viewed teaching as a craft and a set of skills that could be applied across the learning areas:

> *… teaching is a craft and it's something you learn and you've got skills … just like a carpenter or a plumber … if you've got those skills you can apply them to whether you're teaching maths or whatever …* (Hamish)

This view of teaching could be related to the way that Hamish had been able to work for a window glass company based on his lead lighting skills. Because he was able to cut glass, he had been able to transfer his skills into his work as a glazier.

He also regarded himself as adaptable because of the way that he thought he had changed his teaching style with his move to Seaview School. This change could be viewed as further evidence of Hamish's nurturing personality in that he recognised Seaview's children had particular needs and he wanted to meet these needs so that the best possible learning outcomes were

achieved. Consequently, he has changed his pedagogy. However, this change has created tensions for Hamish. The reason for the change came about because Hamish had children for whom English was not their first language in his class and they required a lot of support to improve their English literacy. As a result, two tensions in his teaching style can be identified. The first tension related to having class discussions. Hamish placed value on discussions as a way of learning and this value could be seen in his identification of the *Think, Pair, Share* activity as his favourite activity to use:

> *I really like the Think, Pair, Share, that would be the one that I put through every lesson whether it's maths or reading or whatever 'cause I really think that if children have to talk to each other and explain what they're thinking then they're learning.* (Hamish)

However, a tension arose for Hamish around the issue that the children at Seaview had difficulty sitting still and focusing on discussions and he thought that this adversely affected their learning:

> *They don't sit quietly the way that [the previous school's] children do in order to learn, so before you learn you've got to be able to listen. You have to be able to focus and concentrate and actively listen.* (Hamish)

A second tension was the teaching of topic studies, that is integrated study of a topic through learning areas such as science, social sciences and health. This tension arose because Hamish placed equal value on the children learning literacy and numeracy skills as well as learning through topic studies. Because of the need for children at Seaview to lift their literacy levels, Hamish found that he had to teach literacy skills directly rather than the children learning these skills through topic studies. He referred to this as "learning to read rather than reading to learn". As a result, Hamish felt that he was not able to spend as much of the school day on topic studies as he had in his previous school:

> *… coming to this school it's been quite an eye opener just to realise how hard it is for some kids to learn English, to read and write … but to do topic work you need to be literate, you need to be able to read and write so I've had to kind of slow down and be a lot more measured with the way that you teach topic work and inquiry stuff … the children just don't have the background and the literacy to respond to a lot of that stuff … so it's a lot more literacy and numeracy and of course you want them to have fun as well so sports and arts and crafts is good for them too 'cause it's stimulating for them so topic work is there but it's only like three sessions a week where it used to be five or six down there [previous school].* (Hamish)

Hamish's comments seemed to reveal a sense of frustration in not being able to teach as much topic work in his class as he would have liked due to the literacy needs of some children in his class. This lack of time has implications for EfS teaching because EfS is often taught during topic time and with less topic time available, there would be less time for EfS.

Hamish also placed value on working in a team and discussing ideas with his colleagues, viewing it as an essential part of teaching:

> *… I work in a team … we plan collaboratively … it's most valuable … you need someone to listen to you to say that's a good idea or that's not a very good idea … I find it very useful to plan with other people and to talk … it would be really difficult to teach 'cause you'd just be thinking I'll do this and it may or may not be a good idea …* (Hamish)

This comment also showed that Hamish valued his colleagues' ideas and advice.

Although Hamish never mentioned a learning theory that underpinned his teaching style, based on comments he made, it could be interpreted that he used a social constructivist-linked approach (Skamp, 2008). For example, he commented on the value of discussions and the children talking to each about their thinking and his science teaching began with finding out what the children knew about the topic. Furthermore, while Hamish seemed to adopt a nurturing role in his teaching, on occasion, he also appeared to be able to step back and let the children lead their own learning. This sharing of control could be seen when Hamish mentioned that he used "inquiry stuff", an approach that tends to be child-centred and directed.

In summary, Hamish's teacherly persona was expressed as one where he adopted a nurturing role but was still prepared to share control with his children. He positioned himself as different to his female colleagues in that he emphasised physical activity and viewed teaching as a craft and set of transferable skills which were underpinned by a social constructivist-linked view of learning. He also valued working as part of a team and discussing ideas with his colleagues.

Most of these aspects of his teacherly persona relate to Barnett and Hodson's (2001) academic and research knowledge element of PCxK. For example, the use of a social-constructivist-linked view of learning relates to his knowledge of how children learn, as does his sharing of control of learning. His regard for discussion and working as a team are also important contributors to this element of PCxK, because it is through discussion with peers that this type of knowledge is developed (Barnett & Hodson). Hamish's view of teaching as a set a transferable skills also appears to relate to the academic and research knowledge element, but it could also relate to another of Barnett and Hodson's elements, classroom knowledge. The reason for this relationship is Hamish demonstrated that in order to know what skills were required, he would need to know the needs of the children in his class. Knowing one's children is part of the PCxK element of classroom knowledge, a type of knowledge that is continually being constructed by the teacher.

7.3.3 Understanding about and awareness of sustainability – Hamish's reflections and outcomes of his participation in the workshops

Hamish engaged in the same series of activities as the student teachers as described in Chapter 4 pp. 68-9. His reason for participation in the workshops centred around his concern about incorporating sustainability into his pedagogy so that seven to eight year old children could develop an understanding:

> *I'm really interested in how to teach it 'cause I can see how difficult it is to teach, particularly to Year 3s and 4s and I'm hoping that by the end of the year I will have some*

> *really good ideas about how to teach stuff that is relevant to that age group … how to teach them in a way that it makes sense to them and they get an understanding of it …* (Hamish)

During the workshops Hamish's understanding of sustainability became more complex, increasing in the number of conceptual indicators and theoretical components used. His initial definition was categorised as *Unqualified/Uncontextualised*. It did contain one conceptual indicator but did not comprise of any theoretical components:

> *It means that a system or process can keep going in good health or shape and provide the results it is designed to do.* (Hamish)

Hamish's response was regarded by the researcher as a sophisticated one because he made reference to keeping the system and process in "good health" which could be regarded as indicative of his understanding that sustainability had something to do with being in good condition. However no context was provided and his reference to keeping going was unqualified. Hamish's post-workshop definition contained two conceptual indicators:

> *Ensuring that the planet is not damaged/degraded by human activity and future generations do the same, i.e. educate them.* (Hamish)

The first conceptual indicator in Hamish's definition referred to making sure that people looked after the planet so that it is not damaged and was placed in *Caring for the Environment* and thus related to the environmental component of the researcher's theoretical definition. His second conceptual indicator mentioned that future generations also had this responsibility and that this future goal could be achieved through education. It was placed in the *Future Planning* category and related to the temporal component of the researcher's theoretical definition. Although this conceptual indicator did not make direct reference to planning for the future, being able to educate future generations does require planning systems for that education to take place, and so was regarded as *Future Planning*. It also seemed to show that he thought that people can learn about caring for the planet through education.

This definition could be regarded as further evidence of Hamish's nurturing personality because his view of sustainability was related to care of the planet. His identification of the most important concept he learnt related to his post-workshop definition and also included ideas about nurturing because it referred to intergenerational equity. For Hamish, intergenerational equity was seen as taking a long-term nurturing role in order to preserve the needs of people in the future:

> *… ensuring that the next generation of human beings are able to have the same lifestyle or similar lifestyle as what we have … I see a little fish hook in that … our lifestyle is not very sustainable so their lifestyle will probably have to change to some extent … be more sustainable than ours … what I've learnt … is thinking about the next generation and bringing that into my thinking rather than thinking about what's sustainable right now … an ongoing process.* (Hamish)

Similarly, as in his definition, Hamish's remarks showed a development in complexity of his understanding of sustainability to now include its temporal nature. This development is shown by the way that initially he was focused on sustainability at the present moment but has now started to think ahead to future generations of people and their survival. His comment about sustainability being an "ongoing process" seemed to encapsulate this shift.

Hamish's identification of sustainability issues appeared to show some increase in his awareness of the complexity of sustainability following the workshops. In the initial questionnaire Hamish identified four sustainability issues: energy, food, population and ecology of planet. Apart from the statement 'ecology of planet', all of these issues were a single word. Because his responses were only one word with no qualifying words or phrases used, the researcher decided that this could indicate a lower level of awareness. However, it needs to be remembered that this data is only a snapshot and Hamish might not have been interested in writing more than one word at this time or he might have thought that only one word was needed.

Following the workshops Hamish identified five sustainability issues. What was interesting about his identification this time was that Hamish identified the same issues from the initial questionnaire but this time qualified them using at least two words or a phrase. For example, he extended population to population growth and food to food production. Hamish qualified energy and wrote peak oil, a time when oil production worldwide will peak and then begin to decline in amount (Vermont Peak Oil Network, 2007). He expanded his idea of ecology of planet and listed environment degradation and loss of species. The researcher decided that the use of the same issues with the qualifying words could indicate a growing awareness of the complexity of sustainability.

However, his self-rating did not seem to show an increased awareness of his understanding because he self-rated it as *Very Good* on both occasions. In addition, his high self-rating of understanding did not appear to be linked to his confidence about teaching sustainability, because as stated above, he regarded sustainability as difficult to teach. When using the researcher's scale, the rating of his understanding went from *Little* to *Good*, a shift towards the *Very Good* end of the rating scale, indicating that there was development in his understanding. One conclusion that could be drawn is that Hamish seemed to have little awareness of the depth of his understanding of sustainability.

When identifying the most effective activity to promote understanding of sustainability, Hamish identified the jigsaw activity. His justification of its value related to discussion – a teaching strategy favoured by Hamish with his social constructivist-linked approach to teaching:

> *… jigsaw is quite useful just to generate some discussion … something you do early in a topic … it was the concentric rings, the idea that … economic activity is generated for our benefit but we're part of the bigger picture … which doesn't really care about humans as much so we have to understand that … and adjust our behaviour accordingly.* (Hamish)

Hamish's comment also revealed a change in his thinking. When he commented on the "concentric rings", he was making a connection between the way that the environmental component of sustainability was illustrated as the border of the jigsaw and the strong sustainability model illustrated on p. 21 of this thesis. This connection seemed to make Hamish think that humans needed to change their behaviour, particularly economic activities, to protect the environment, which he regarded as having paramount importance.

In summary, Hamish's participation in the workshops seemed to result in his understanding of sustainability developing in complexity and the data indicated that he was beginning to be aware of his understanding. His post-workshop definition of sustainability appeared to reveal his nurturing personality as did his reason for participation. The social constructivist-linked learning theory that seemed to underpin Hamish's teaching was also evident in his reasons for choosing the jigsaw activity as the most effective as well as revealing a change in his understanding of sustainability.

7.3.4 Topic choice for teaching about sustainability: Using a science focus

Hamish planned to teach EfS within science, which is the most common choice of learning area for New Zealand teachers when teaching EfS programmes (Eames et al., 2008). It appeared that the school scheme for teaching science placed no restrictions on the topic as long as it fitted within the Living World strand of the science curriculum. Hamish chose the topic of bees for his Year 3 class (7-8 year olds). His interest in bees seemed to stem from their important role in a garden and his choice could be evidence of his personal life intersecting with his professional life. Further evidence of his interest in bees was his choice of an article that discussed the global pollinator crisis when asked to choose a media article that illustrated his understanding of sustainability. Hamish said that he had chosen the topic of bees because he:

> *… thought that bees would be a good example of the interrelationship between different parts of the environment and humans are involved as part of the environment. So we thought we could make some connections between how bees survive and … how bees help humans. One of the focuses was that bees help humans to grow food or to produce our food and if we didn't have the bees, we wouldn't be able to grow as much food. So it's about human sustainability.* (Hamish)

Not only did Hamish make reference to sustainability when justifying his choice, he also revealed his nurturing qualities. For example, he said that he wanted the children to learn about interdependence between people and bees or in his words "how bees help people". By discussing the important role of bees in pollination and consequently food production, he could have been emphasising the importance of bees to people and a desire for the children to be aware of this relationship and start caring about bees. Hamish also referred to "human sustainability" which he explained as interdependence between people and the environment. By including people as part of the environment, he appeared to show an eco-centric attitude.

7.3.5 Planning for teaching: The invisibility of sustainability in curriculum documents

Even though Hamish intended teaching about sustainability, his planning was very science focused and contained only one reference to sustainability (Appendix Q). Knowing how to plan a series of lessons for effective learning is part of the pedagogical content knowledge element of Barnett and Hodson's (2001) PCxK and knowing how to use curriculum documents relates to PCxK's professional knowledge element.

Even though there was only one reference to sustainability, there were aspects in his planning that could be regarded as sustainability-related. For example, the plan contained 14 scientific understandings to be taught over seven weeks, three of which could relate to sustainability. These were:

> *Bees are very important to our survival as they help particular plants to reproduce*
> *The variety of food that we eat will be different if bees don't pollinate*
> *Many bees world-wide are dying and no one knows why*

Although there is no mention of the word sustainability, these scientific understandings could be regarded as sustainability-related because they focus on the relationship between people, food, plants and their pollinators (bees). Without plants and their pollinators, there would be a limited range of food for people.

This plan included seven learning intentions and three were sustainability related. In one the word sustainability is mentioned:

> *Evaluate the importance of bees and discuss ways we can protect them, sustainability*

The other two were linked to the interdependence of people, food, plants and pollinators:

> *Understand how bees and flowering plants depend on each other*
> *Understand how bees help us*

The final experience in the lesson sequence was sustainability-related because it mentioned the taking of action, an essential element of an EfS programme:

> *Design a garden that will attract bees (The bank at the back of Room 1)*

There was one mention of assessing the children's understanding of sustainability in the listed assessment tasks:

> *Children can discuss, what if there were no bees?*

Even though there are signals that provide space for the teaching of sustainability in *The New Zealand Curriculum* (MoE, 2007), no sustainability relevant key competencies, values or achievement objectives were evident in Hamish's planning. These omissions could be related to

Hamish not being sure about where to find signals to sustainability in the curriculum document. His uncertainty was shown when asked where sustainability could be found in the curriculum:

> *I know that it's not a curriculum area, I know that it's like a value or, I forget what the other one is. So it's kind of in there.* (Hamish)

7.3.6 Introducing about sustainability: Resolving the dilemma

As previously discussed, Hamish was concerned with how to teach sustainability in a way that his 7-8 year old children would understand. He was still struggling with this dilemma as he began teaching.

Hamish's constructivist-linked learning approach was apparent when he launched into the topic by finding out what the children knew about bees using annotated drawings and having them assemble a jigsaw of a bee's body parts. He then started off the EfS programme by teaching the children about the structure of a bee. When asked by the researcher about that decision, Hamish spoke about learning being:

> *… a series of building blocks. It's like teaching children to read. They have to know the alphabet and have to know some vowels and some sight words and all those things … I don't think they could put it together unless they had the building blocks.* (Hamish)

By starting with a bee's structure, he thought that the children could build on this knowledge and construct more complex understandings about bees and consequently, about sustainability.

Two weeks into the teaching, the researcher asked Hamish whether he had introduced the idea of sustainability yet and Hamish said that he would do it during the next couple of weeks. Up to this point in time Hamish had struggled with how to teach sustainability but appeared to have solved this dilemma as is shown in the following comment:

> *… I've always said I'm struggling to figure out the best way to give them the ideas of sustainability and I think this is a good way to do it because when they understand that bees pollinate plants then you can say well if a bee didn't pollinate the plants then we wouldn't have the plants so where are we going to get our food from? So that's a meaningful question at that point. It's not a meaningful question if I said to them tomorrow morning where does your food come from? What would happen if there was no food? They'd say you go to the supermarket or something … you need to build up little bits and pieces but having your own goal in the back of your mind.* (Hamish)

Hamish's comments showed how he solved his dilemma by realising that he needed to contextualise sustainability for the children. Without a context, he thought that learning about sustainability would not be meaningful for them. Unlike the workshops where the researcher was able to talk about sustainability in abstract terms, Hamish planned to provide a context by teaching about the bee's structure and function, then about pollination and the life cycle of a plant; in other words teach content knowledge, so that he could contextualise sustainability within the children's understanding of the interdependence between people, bees and plants. He also related his solution to his belief about learning being a series of building blocks with the teacher

guiding the learner using their knowledge about the direction in which the learning should be going.

Five weeks into the teaching of the EfS programme Hamish introduced the concept of sustainability. He did this introduction by telling the children:

> *… sustainability is how you keep going from one year to the next or from one generation to the next so we had to give them that idea of keeping going.* (Hamish)

In this explanation, Hamish's personal understanding is apparent. His post-workshop definition and his identification of the most important concept learnt both contained the idea of intergenerational equity. He indicated that thinking ahead to the next generation and them being able to have a similar lifestyle as we have today was important to him. This idea of "keeping going" was abstract so the researcher asked Hamish how he made the connection between this definition of sustainability and bees for the children. Hamish explained how he made the connection:

> *… because people take honey and bees store honey to keep going over the winter and if bee keepers take too much honey then they [the bees] wouldn't be able to keep going over the winter and they would die.* (Hamish)

In this way Hamish established the connection by contextualising sustainability into a situation that the children had learnt about, that is the way in which bee keepers had to be careful to not take too much honey from the hive. He then used this contextualisation of sustainability to introduce the idea of bees pollinating plants so that plants could keep going and that people need the plants to survive so that we have food to eat. Therefore, bees are important for people to survive.

The way in which Hamish resolved his dilemma about teaching sustainability to this age group of children showed his use of two of Barnett and Hodson's (2001) elements of PCxK. He used academic and research knowledge about sustainability and bees to present a definition of sustainability that the children could understand. Secondly, Hamish made use of his pedagogical content knowledge, another element of PCxK, to decide when to introduce the concept of sustainability in a way that would be meaningful to the children.

This account also revealed aspects of Hamish's identity as a teacher of EfS. He seemed to have a science-focused conception of EfS with an emphasis on the environmental component of sustainability. This focus could be seen in the way that Hamish emphasised content knowledge about the bee-plant-people relationship (environmental component). He did not appear to include ideas about the ways that people used bees in horticulture or the production of honey on a commercial basis (economic component). Up to this point he had not included any teaching about how people are able to support bee populations (social component), such as building hives and providing nectar-bearing plants.

7.3.7 Teaching strategies – different ways of learning about sustainability

Hamish used a variety of ways to teach about sustainability, namely integration, an inquiry approach and hands-on learning in the 'real world'. The teaching strategies he chose related to two elements of PCxK, pedagogical content knowledge and classroom knowledge (Barnett & Hodson, 2001). Classroom knowledge is described as being the knowledge that a teacher has about their particular class and the way that a teacher continually adjusts their teaching based on this knowledge. In addition, one of the aims of EfS is to foster feelings of concern for the environment (MoE, 1999) and Hamish discussed the role affective learning played in his EfS teaching.

Hamish's preferred teacher style was to integrate a variety of learning areas into the bee study as well as science. Opportunities for developing understanding about sustainability were offered not only through science but also through social studies, oral language, reading, writing and art. His incorporation of different learning areas meant that the children could engage with the idea of sustainability in many different ways to give more opportunities to construct their understandings.

Although Hamish adopted a predominantly nurturing role as a teacher, he was also able to share control of the learning with his children and this sharing could be seen when he used an inquiry approach during the bee study. At the start of the study all of the children posed questions about bees for which they wanted to find answers. For example Child BC8 wanted to know:

> *How many times do bees flap their wings in a minute? And*
> *Why do bees make honey?* (Child BC8, Summative Task)

At the end of the programme, the children wrote answers to their questions. They then thought about what they had learnt and realised that they now knew much more about bees. Hamish said:

> *… [had] two questions at the beginning … and then at the end of the unit they were saying things like oh I've learnt a lot … I know that they do this and do that and so <u>they could see the learning</u>.* (Hamish)

Hamish also designed a summative assessment task that required the children to display the knowledge that they had constructed during the programme. This task was a series of questions that the children had to answer and present on a chart. The questions related to the bee's appearance, the hive's social organisation, how it protected itself, its life cycle and sustainability. The question about sustainability read:

> *If the beekeeper took too much honey, what would happen to the plants? What would happen to people? What would happen to the bees?* (Hamish)

An important part of EfS is having hands-on experiences outside the classroom as this type of experience can foster feelings of concern for the environment (MoE, 1999, p. 9 and p. 14). Although Hamish did not make this link between experiences outside the classroom with the development of feelings of concern, he did place value on such experiences. His reason for their

value was that these experiences enriched the children's learning because it connected the children's learning to illustrations of sustainability in real life:

> *It's confirmation, isn't it? Confirmation for the children that what they're reading is real … actually seeing the things that they'd been … seeing all the pictures of.* (Hamish)

For example, the children in Hamish's class visited a honey centre north of Auckland to see a bee hive and talk to the bee keeper about his work. This visit provided an example of the social and economic components of sustainability. Another activity that made connections between the children's learning and a real world example of animal, plant and human interrelationships was their observation of bees and the growth of broad beans in Hamish's team's garden:

> *We've got some broad beans growing out there and we looked at them, the way that the bees were pollinating them and then just today we've noticed that we've got lots and lots of beans so they must have been pollinated so there must have been some bees. We've going to harvest the broad beans tomorrow and eat them.* (Hamish)

Hamish's last activity providing opportunities for the children to make connections between their understanding about sustainability and their world was his idea to encourage children to help him to create a bee garden, which could have illustrated the environmental and social components of sustainability. This activity appeared to follow from both Hamish's interest in bees and reflect his nurturing personality. It followed because he wanted to create a garden that would provide food for bees and could also help to foster children's feelings of concern for bees. Additionally, the creation of such a garden could be regarded as taking action, an essential element of an EfS programme where the children would be applying their understanding of sustainability to solve a relevant environmental issue. Although it was not the children's idea, they were still responsible for taking the steps to create this garden. Hamish said that he had come up with this idea during a discussion with a colleague where it was decided to:

> *… sort of lead the children into that [creating the bee garden] by talking about how bees might be endangered or there aren't as many bees around as there ought to be so to lead them to that thing about what could we do.* (Hamish)

After having a discussion that led the children to the idea of creating a bee garden, he encouraged the children to look for bees around the school during their morning tea and lunchtime. This activity promoted another connection between the children's learning and the world outside the classroom and Hamish commented on its value:

> *They got very interested and they would come back and say that they'd seen a bee and they'd seen its pollen sac and they figured it must be getting pollen from somewhere. So they got quite engaged.* (Hamish)

Next Hamish took the children for a walk around the school to look for a suitable location for the bee garden and with prompting from him about finding a place for the garden where the children were not allowed to play, a suitable site was found. Finally the children wrote letters to the

Principal to request permission to begin planning for their bee garden. At this point, the end of the term had come but Hamish planned to continue the creation of the garden even though it was not part of the next term's planned teaching. He was planning to continue with it the following year in order to realise a garden planted with nectar-providing plants for bees.

One of the aims of EfS programmes is to foster feelings of concern for the environment (MoE, 1999). When asked how he did this in his programme Hamish said that he thought that knowledge needed to come first as the children couldn't feel concern about something they didn't understand. Then Hamish said:

> *Action would be preceded by some sort of emotional response wouldn't it, you wouldn't really want to go out and save the bees unless you felt they needed saving.* (Hamish)

This comment seemed to indicate that Hamish recognised the power of the affective domain in driving the taking of action on an environmental issue.

Hamish's use of integration and an inquiry approach to develop children's understandings of bees and sustainability illustrate the PCxK elements of pedagogical content knowledge, academic and research knowledge and classroom knowledge. He used his pedagogical content knowledge about how to integrate different learning areas so that the children got opportunities to learn about bees and sustainability in different ways. For example, they read about the life cycle of bees during reading, discussed the life cycle through oral language and then wrote about it in the summative task. Hamish could have used his knowledge about the different needs of the children to give appropriate support to individual learners during these activities, which is his use of the classroom knowledge element and the academic and research knowledge element. Using the inquiry approach involved his pedagogical content knowledge as well. Hamish would have had to assemble the resources for the inquiry part of the programme, assisted the children in finding answers to their questions and then given them opportunities to record answers to their questions. Again, he used the PCxK element of classroom knowledge to support children in their learning.

His choice of teaching strategies also illustrated the way he was positioning himself as an EfS teacher and thus making it part of his identity. As mentioned, two of the aims of EfS are to foster feelings of concern for the environment and to empower children to take action on environmental issues (MoE, 1999). His use of teaching strategies showed how he directed his teaching towards these aims. For example, he placed high value on experiences outside of the classroom because he thought that it helped children make connections between the classroom and their world. These children experienced the honey centre with its bee hives. This was an illustration of a commercial venture directly resulting from bee activity. They were also able to make connections by seeing bees in the school gardens and the way that the flowers grew into broad beans through pollination. By teaching the children the close connection between bees, crops and production, it could be argued that he was trying to foster feelings of concern about bee survival. Then, by encouraging the children to consider the design of a bee garden, Hamish was engaging those feelings of concern to motivate the children to undertake the design.

7.3.8 Reflections on teaching

At the conclusion of his teaching, Hamish was positive about his experiences teaching sustainability and the children's learning. He commented about having built a foundation of understanding about sustainability and the taking of action:

> *I was very happy. I think that just being introduced to the idea of sustainability and the idea of interdependence and the idea of social action that we can actually do something. I think they've had a good experience.* (Hamish)

Hamish's idea of having built a foundation of understanding relates to his idea about learning being a series of building blocks where teachers need to teach the basic ideas so that children can then construct future learning on these ideas. This idea of learning can be regarded as Barnett and Hodson's (2001) academic and research knowledge element of PCxK because it is knowledge about how people learn.

Hamish was confident that some children had learnt about sustainability and would take that understanding with them into their future learning:

> *… they did learn some stuff, not all of them of course but not all children do but I think the brighter kids figured it out and I think they'll take something through into Year 4 and Year 5 and if that sort of consciousness, if it's maintained and taken through, the continuity of it I think would be really good … it would be a shame if they never heard that word again until they got to high school …* (Hamish)

In terms of his identity as a teacher of EfS, this comment seemed to show the value that Hamish placed on learning about sustainability. It also showed his belief that EfS should be part of each year level's teaching so that the children would have opportunities every year to continue this focus.

7.3.9 Children's learning about sustainability

Eleven of Hamish's class of children returned signed parental permission forms and gave their assent to be interviewed. This number represents just under half of his class. These children were interviewed individually at the conclusion of Hamish's EfS programme. The interviews began with the researcher showing the children three pictures depicting the three types of honey bees (See Appendix O). The researcher then began a conversation with each child by asking them to identify the types and bees. Next the conversation led to asking what they knew about bees and why were bees important. During the semi-structured interview, the researcher was looking for evidence of these children being able to explain the interrelationships between bees, plants and people; being able to state the definition of sustainability taught and their ability to give an example of sustainability.

Table 7.2 presents the findings of the interviews with the children. Ticks were used to represent an instance. For example, if the child was able to state the taught definition, one tick was placed in the definition column. If the child could state an interrelationship between two of the organisms,

a tick was placed in that column. If they could identify another, a further tick was placed in that column. Black ticks represent responses from the interview.

The researcher was also able to access some of the children's written work from their summative task. This writing was their responses to the last question about sustainability. Not all children responded to that question and those children whose work was available are indicated on Table 7.2 with a red cross beside their name. In a similar manner to the interview, ticks were used to indicate the instance only this time, red ticks were used.

Table 7.2 Hamish's class of children's understandings of sustainability

Child	Expressed definition	Stated inter-relationship between 2 organisms	Stated inter-relationship between 3 organisms	Gave example of sustainability
BCS1+	√ √	√		
BCS2+	√	√ √ √		
BCS3	√	√ √		
BCS4				
BCS5				
BCS6+		√	√	
BCS7+		√	√	
BCS8+	√		√ √	
BCS9	√			
BCS10+		√		
BCS11+	√	√	√	

Notes. √ represents an instance of the column's criterion from the interview
\+ represents that this child's written work was available and analysed
√ represents an instance of the column's criterion from written work

Table 7.2 shows that six of the 11 children were able to express a definition of sustainability that was similar to Hamish's. Child BCS2's statement is an example of this type of response:

> *Sustainability means keep on going …* (BCS2)

Seven of the children were able to talk or write about the interrelationship between two organisms and two were able to give more than one example of an interrelationship. Child BCS1 was able to give an interrelationship example in the interview. When asked why bees were important they replied:

> *They are really important to us and they make us keep going.* (BCS1)

The researcher then asked how did they make us keep going and they said:

> *Because food is good for us and if we don't have food we'll starve and then we don't get any food to eat and then we'll die.* (BCS1)

This sequence of answers illustrated the way that this child was able to identify the way that bees have a role in the production of food for people but was unable to identify the role of plants in this interrelationship. BCS3 could identify an interrelationship between bees and plants:

> *Because if they [bees] didn't make, if they didn't find flowers and collect nectar there would not be any more flowers … because they didn't fertilise it much.* (BCS3)

Although not expressed scientifically, BCS3 was discussing the pollination and fertilisation processes necessary for plant reproduction. These two responses are indicative of the way that four of these seven children were able to either discuss or write about one interrelationship, like the one between bees and plants or else people and bees, but seemed to be unable to express an understanding of the interrelationship between bees, plants and people.

BCS6 and BCS7 were able to talk about an interrelationship between two organisms in the interview and in their writing they were able to connect all three organisms. For example, in the interviews BCS7 said:

> *Bees are a really important animal … because we would die in four years if there weren't any … because they make food for us, they pollinate flowers … it [pollination] makes seeds and food.* (BCS7)

When asked if the bees need us or we need bees, BCS7 thought:

> *It's kind of both. Bees need us to grow flowers and we need them to grow food.* (BCS7)

This response seemed to show that BCS7 understood the relationship between bees and people, but was not aware of the way that plants are dependent upon bees for their survival. BCS7 appeared to think that people had this role. However, in her response to the question on the chart BCS7 wrote:

> *What if there are not enough bees? Well some plants would die. They need bees to pollinate the flowers so they can make seeds. What would happen to us? There might not be enough foods. Some of our plants need to be pollinated. There would be no honey.* (BCS7)

In this written response, BCS7 seemed to be aware of the role of bees in plant reproduction and also their role in production of people's food. Thus, this response was regarded by the researcher as evidence of understanding about an interrelationship between three organisms.

One child (BCS11) was able to explain the relationship between bees, plants and people in the interview. When asked why bees were important, BCS11 explained how they pollinate flowers to make seeds, which were initially referred to as "babies":

> *They put pollen, like you have a flower and the bees get pollen all over them and then here's a flower and then it goes onto what's it called, from the stamens to the [stigma] … it makes babies … seeds … for to grow some more flowers.* (BCS11)

Then when asked why the pollen was important, they said:

> *Because we would only live for like five years or six.* (BCS11)

When asked why this would happen she replied:

> *Because we don't have enough food, because we won't have milk products because cows make milk and they need grass and bees pollinate the grass.* (BCS11)

Although not scientifically correct, BCS11 was attempting to explain the interrelationship between people, plants and bees by discussing the way that cows make milk from grass, bees pollinate the grass which could imply their role in grass reproduction and without grass, people wouldn't have enough food because there would not be any milk. However, when answering the assessment question on the chart BCS11 wrote about the interrelationship between only two organisms:

> *What would happen if there were no bees? There would not be enough food for us. Plants need bees to pollinate. Some plants would die if there were no bees.* (BCS11)

While this response does mention food for people, there is no connection made between the role of bees and the production of food. Instead BCS11 just wrote about the bee's role in plant reproduction.

One child, BCS8 could discuss the interrelationship between three organisms in both writing and in the interview. In the interview BCS8 stated that worker bees were important because they pollinated flowers. When asked what happens then, this child replied:

> *It's going to make seeds and fruit … for us …* (BCS8)

When asked what would happen if there were no bees, they said:

> *The animals might die and the flowers … we won't get much food.* (BCS8)

In this response, BCS8 seemed to show an understanding of the bee's role in plant reproduction and food production and this understanding appeared to be evident in their writing:

> *What would happen if there were no bees? Plants would die. They need bees to pollinate so they make seeds. There might not be enough food. Some of our food needs to be pollinated. There would be no honey.* (BCS8)

Two of the 11 children did not seem to be able to express any relevant ideas about sustainability and one only expressed a definition. No child was able to give an example of sustainability.

It might seem that the ideas given by the children above are examples of sustainability. However, during the interview after the researcher had asked children about bees and their importance, the researcher asked each child what they thought sustainability meant, in other words a definition, and then asked for an example of sustainability. Here, the researcher was looking for the child being able to connect their examples of the bee-plant-people interrelationship to the word sustainability. While some, for example BCS1, did talk about bees helping people to keep going, Hamish's definition, the children did not appear to have connected the word sustainability with Hamish's definition of keeping going and the interrelationships about which they had learnt. For this reason, the final column was left blank. In addition, these children's stated definitions related to the temporal component of sustainability, even though Hamish identified the enivronmental component as most suitable given these children's young age.

7.3.10 Hamish's category of identity as an EfS teacher: Intersection of personal life, professional life and personal beliefs

Using the identity characterisation tool (p. 136) and taking all of these data into consideration, the researcher decided to place Hamish in the *Complex* category. Although his post-workshop definition was researcher-rated as *Good*, all of his sustainability issues were contextualised. In his personal life Hamish seemed to be making many sustainable choices such as waste and energy reductions and gardening:

> *I don't think I'm doing anything different. We've got a worm farm going, we do lots of gardening, vegetables … I walk to work and cycle to work … my wife takes the train to work … we've only got one car … we try to … conserve energy as much as possible. We've got a heat pump … got those new bulbs … recycle … we only put out the red bin [bin going to landfill] once a month …* (Hamish)

At school he also had implemented recycling in his classroom and his team had a garden that they tended. Hamish said that he felt his personal life practices influenced his school practices:

> *They inform my teaching because what I do at home, it's the practical things that I do at home I can use at school, especially my gardening skills …* (Hamish)

Even though Hamish was initially concerned about how to teach sustainability, at the conclusion of his EfS programme he discussed the way that he actually didn't have to change the way he taught in order to incorporate sustainability:

> *As I said before, whatever you're teaching, you've got certain skills and certain ways of doing it that, it doesn't matter what the topic is … I think you have to find a hook, you have to find a context … so I don't think it's changed our teaching or our planning particularly … but it's just saying we need to find a curriculum area to put it into 'cause it's not a curriculum area … so I think it's just about finding a way to get into it …* (Hamish)

Hamish's remarks here seemed to show his belief that sustainability could be taught by finding a curriculum area in which to put it and then finding a "hook" or way to contextualise sustainability in order to engage the children in the topic. Hamish also said that he would be incorporating

sustainability into his future programmes by saying, "I came to the conclusion that it was successful and therefore I'd like to do it again."

Hamish had a leadership role in Seaview School as the head of the Enviro Curriculum Team. The role of this team was to encourage the other teachers to include EfS in their classroom programmes, lead the WasteWise and Travel Wise programmes, as well as oversee the school gardens, compost and worm farms. Hamish commented on his role:

> *I didn't actually ask for it and I've sort of done it. I don't really like being a leader. It's not what I really am. I don't really enjoy getting up in front of people … I find it hard enough being a classroom teacher …* (Hamish)

A possible reason for his reluctance to take a leadership role could be that Hamish preferred his nurturing role and found leading conflicted with being a nurturer. Hamish also spoke about the influence of this role on his teaching and on other teachers:

> *Well, I guess it ensures that we have got an environmental sustainability focus in our [team] planning … I think that if I didn't push it [the environmental focus] it wouldn't happen, so in that sense I don't get influenced by them [other teachers], it's the other way round …* (Hamish)

Although the Principal was supportive, Hamish also remarked on the difficulty that teachers face with the many competing interests, such as running sports teams, organising concerts or being in charge of the school choir or orchestra, and the consequent difficulty he faced trying to implement EfS programmes and practices within the school:

> *But there's a lot of teachers around the school that are not negative but neutral and you know, there's so much to do as a classroom teacher that if you're into music or you're into sport you kind of focus on what you're doing and then someone gets up and says oh we've got to all be sustainable and they just sort of sigh and say,do we really, do we have to?* (Hamish)

Hamish felt it was important to teach children to care for the environment which shows the value he places on nurturing:

> *I think there's a lot of value in teaching children to care for their environment … but you need to find a way to do it that it's meaningful to them.* (Hamish)

The researcher asked Hamish what he thought about the political dimension of EfS, in other words exposing his personal values and beliefs about sustainability to the children. Hamish's response showed that he thought that there was a line which he would not cross:

> *I think the implications of not caring for the environment are not something that you teach children beyond a certain level … you know, there's millions of people in Bangladesh who in ten year's time may not be able to live where they live, but you don't go and tell them that … they wouldn't get it anyway, you know, they're only seven and they live in this beautiful safe place in Auckland.* (Hamish)

This comment seemed to show a tension between what Hamish thought and what he was prepared to teach. This tension was also revealed when he commented on not trying to force his ideas on others:

> *You have to live in the staffroom and you can't go around saying, you know, put that tea bag in there otherwise … there's all sorts of people out there in the world and if everybody thought the way that we did, then we wouldn't have a problem. Also I mean we're just five million people in New Zealand and too many coal-fired power stations are being built each week in China and what can you do? You can't say to the Chinese, you can't have power when the only source of power they've got is coal, well the only cheap one.*
> (Hamish)

Consequently, because of the way in which Hamish developed a deeper understanding of sustainability, implemented sustainability into his classroom programme and practices, influenced school-wide sustainability practices and intended to continue, he was placed in the *Complex* category of identity characterisation as a teacher of EfS.

This analysis has depicted Hamish as a person who is a nurturer, both of people and of the environment. This nurturing quality can be seen in his perceptions of himself as a teacher and in his definition of sustainability which related to caring for the planet. His personal life intersected with his professional life in the way that he brought his sustainable lifestyle practices into his classroom and supported gardening in Seaview School.

Hamish thought that it was important for children to learn about the environment. This belief was illustrated by the way that he reluctantly took responsibility for leading the environmental curriculum team and promoted EfS throughout the school. However, even though Hamish thought it important for children to learn about the environment, he qualified his belief, which indicated a demarcation line between what he believed and what he would teach. He thought that teaching environmental issues should be those appropriate and meaningful to children dependent upon their age level. In these ways, he built his identity as a teacher of EfS at Seaview School.

The next section tells the story of Mike who taught in a Year 1 class of children aged between five and six years.

7.4 Mike's story – a scholarly and reflective approach

Mike's story follows the same format as Hamish's, beginning with a brief account of his life. In Section 7.4.2 Mike's perceptions of himself as a teacher are presented. The development of Mike's understanding and awareness of sustainability is discussed in Section 7.4.3. The next section, Section 7.4.4 presents his reasons for the topic chosen for his EfS programme and an analysis of his planning is given in Section 7.4.5. How Mike introduced and taught the concept of sustainability is presented in Section 7.4.6 and the teaching approaches he used discussed in Section 7.4.7. His reflections on his teaching of this EfS programme are given in Section 7.4.8 and what his class of children learnt about sustainability is presented in Section 7.4.9. The final

sub-section, Section 7.4.10 discusses Mike's category of identity characterisation as an EfS teacher.

7.4.1 Mike: Personal and professional

Mike came from a large provincial town and was in his mid-thirties. He was in the second year of his teaching career, having just completed a three year Bachelor of Education (Tchg) primary specialisation degree. He was yet to be fully registered and consequently was being mentored by an experienced teacher.

Mike spoke about the way that he had always been interested in the environment. He referred to himself as "outdoorsy" and talked about the way that he liked going to the beach and camping because they are stress-free places where you can get away from the "hustle and bustle" to enjoy nature in the fresh air. Mike also said that he liked farms because of his love of animals.

When Mike talked about his childhood, he recounted how gardening was "in the family". Not only did his grandfather win prizes for his tulip gardens, Mike's parents grew food for their family and kept chooks.

Because of a passion for food, Mike made his initial career choice of being a chef while still at secondary school. He mentioned that he was one of only a few males in the home economics classes. After training at a technical college, Mike worked in a restaurant and then got a position in the nutrition department at the provincial hospital. This position involved managing people and Mike said that he found he enjoyed this work.

In his late twenties, Mike went on his overseas experience, travelling to England and Europe where he lived in some of the world's biggest cities such as London, Paris and Rome. It was while Mike was living in these cities that he became aware of detrimental effects of pollution and recounted how this awareness made him realise how relatively 'clean' New Zealand is. Consequently, on his return to New Zealand, he reported a sense of commitment to and awareness of protecting the environment. Mike's observation of pollution can be regarded as a factor that can lead to environmental awareness. According to Chawla and Cushing (2007), witnessing environmental degradation can be a significant experience that leads to developing a sense of environmental responsibility.

When asked why Mike had chosen to re-train as a teacher, he spoke about when returning from overseas, he re-assessed his life. This is evidence of his reflective approach. He wanted to go to university (which could be evidence of his scholarly approach) and had friends who encouraged him to consider teaching. Since he had enjoyed being involved with coaching and training adults in his role in the hospital nutrition department, he decided to take his friends' advice and train to be a teacher.

7.4.2 Self-perceptions of being a teacher

Mike was able to talk about his teacherly persona in a scholarly way by relating what he did to learning theory. This approach could have been because it was his second year of teaching and he acknowledged that the "contemporary philosophy of teaching" he had encountered at university had affected his teacherly persona.

Mike discussed his teaching in terms of learning theory:

> *I'm a co-constructivist teacher … first it's building that knowledge alongside the children but then after a while it is working out how your teaching or your planning or your activities are going to adapt to their learning in a way that they can use their own skills and build on their own skills with the help of your conferencing to just build on that knowledge …* (Mike)

This comment showed that Mike initially supported the children's construction of understanding but then looked for ways of withdrawing that support so that the children were then able to learn independently – an indication of a belief in child-centred learning. This view also illustrates his use of a Vygotskian 'scaffolding' approach (Hodson & Hodson, 1998).

Mike also talked about the way he encouraged children to take risks:

> *… with me working alongside them … they can try things out and find out if it's going to work or why or if it's not going to work and why is that so they can actually see it for themselves rather than me telling them all the time they actually get more involved that way and because they're all so diverse in ability, it's a really good way of doing things …* (Mike)

This comment showed that Mike saw risk taking as advantageous because it fostered engagement in learning and addressed the problem of the diversity of learners in his class.

The above remarks also showed his belief in his role as a teacher as the support person and when questioned further about this role said:

> *… it's really sort of inquiry based wherever possible. I just think it's more powerful that way … because they're more in charge of their own learning and the direction that they want to take it … [it is important] because we're all different and we all learn in different ways and see the world in different ways and we all have different knowledge and life experiences we bring to a situation … our way that we learn is going to be different and it's … easily adaptable …* (Mike)

Mike seemed to utilise an inquiry approach when teaching and justified its use. His reason was because of the autonomy that it gave learners and this appeared to be important to Mike when he emphasised the way that people are different in terms of their learning, worldviews, knowledge and life experiences. Mike seemed to regard an inquiry approach as beneficial because it enabled individuals to adapt their learning in a way that suited them.

Mike not only saw learning as an individual activity, he also viewed it as a social activity with discussion being a crucial part of learning:

> *… they just don't learn individually but they also learn in a group and they learn socially from each other as well … people learn off other people so that's important … just sharing ideas really sort of empowers the other children … so that whole oral language is extremely important …* (Mike)

Not only did Mike encourage risk-taking, he also tried to extend his children's learning:

> *… with learning outcomes we always really have three that you assess on, two that you know that they're really quite capable of and then one that is a little bit more challenging maybe. And that will give you somewhere to go next time.* (Mike)

This comment about him challenging his children's thinking could also be evidence of his scholarly approach. By setting a learning outcome that was challenging, he was encouraging his children to extend their learning beyond their current level of understanding.

Similarly to the way he gave his learners the opportunity to take risks, Mike acknowledged that he too took risks and tried new strategies in his teaching. His reasons for this approach also seemed to illustrate his reflective approach:

> *… it's about trial and error … being flexible and realising that not everyone has the same idea and background … nothing ever stays the same … so you could never have one generic way of doing things … it's always about thinking and finding out what will work and what won't work and sort of mixing things up a bit and taking risks … I actually find that quite interesting … you do the long term planning but then you really just have to feel along the way to see how things are going to work.* (Mike)

Mike spoke about the way that he found discussions with his colleagues invaluable and showed that he was not afraid of asking questions, which could be further evidence of his reflective approach:

> *I'm forever badgering people … it's extremely [valuable] … usually nine times out of ten I walk away with what I wanted, quite happy going back to my classroom knowing exactly what I've got and how to use it and who I'm going to use it for … I hope I never stop doing it … it's really important to actually be really collegial …* (Mike)

He also indicated the way he used and valued reflection to improve his pedagogy:

> *…[reflect] every day … you have to … otherwise how would you know whether it's working or not and who's getting it and who isn't and how to adjust things? I'm constantly taking risks but they usually pay off … you sort of think about it first and think, well what happened, how did that go, what went good, what went bad, how can that be improved next time … what caught their attention and what didn't and I'll usually go with what caught their attention.* (Mike)

This comment was also indicative of Mike's reflective approach because he was constantly inquiring into his own pedagogy in order to make improvements and provide quality learning for his children.

In summary, Mike's teacherly persona was one where he expressed himself in a scholarly manner by associating his pedagogy with learning theory. He also acknowledged the value of discussion

in learning, which is further evidence of his knowledge of learning theories. This scholarly approach also seemed evident when he discussed the way that he challenged children's thinking by aiming learning at a level higher than their current one. Mike saw himself as a support person for his children when they were learning, but then withdrew this support as needed to encourage them to take responsibility for their own learning. He also recognised that he took risks in his teaching, an approach he appeared to value because he also encouraged his children to take risks.

Mike's scholarly and reflective approach to his teaching could be indicative of his use of academic and research knowledge, one of Barnett and Hodson's elements of PCxK (2001). His use of this type of knowledge was shown by the way that he was able to talk about his teaching in terms of learning theory as well as his use of inquiry and reflection to improve his pedagogy. Barnett and Hodson argue that it is through the use of inquiry and reflection that this type of knowledge is developed. Because this was Mike's second year of teaching, it could be that he was still developing his academic and research knowledge and hence a reason for the high value he placed on these activities. Mike's view of himself as a support person for his learners is also indicative of the PCxK element of academic and research knowledge. His justification for his belief was based on a child-centred approach which was further evidence of use of this element.

7.4.3 Developing understanding and awareness of sustainability

Mike also engaged in the same series of activities as the student teachers which were described in Chapter 4 pp. 67-8. He decided to participate in the workshops because he wanted to develop his understanding of sustainability and expressed a lack of confidence in his level of understanding. His desire to know more and lack of confidence about what he knew seemed to reflect his scholarly approach. He also decided to take part because he wanted to include it in his pedagogical repertoire:

> *I wanted to find out, to learn more about sustainability so I can put it into my practice in my classroom and also for my own knowledge base. I wasn't totally confident that I actually knew what it actually involved.* (Mike)

By the end of the workshops, Mike's understanding of sustainability seemed to have developed in complexity. His initial definition contained one conceptual indicator but no components of the researcher's theoretical definition:

> *Sustainability is best explained as a long lasting process or object.* (Mike)

Although there is reference to a process or object being "long lasting" which could be indicative of a temporal component, no context for either a length of time or thing to be kept going was provided. Therefore, the researcher placed this response in the *Unqualified/Uncontextualised* category (coloured blue-gray).

Mike's post-workshop definition contained four conceptual indicators and three of the researcher's theoretical components. It is a scholarly response because of the way it frames sustainability in an abstract fashion in terms of information and assets:

> *Sustainability in my understanding is resourcing information and environmental assets. A sustainable resource is one that is long lasting and has a re-usable purpose. Sustainable resources have a positive impact on the environment and society. Sustainability can come in many forms including technological programmes which optimise the way people use their environment in everyday life.* (Mike)

The first conceptual indicator (coloured red) was placed in *Resources*. His definition of a sustainable resource was regarded as sophisticated because of his reference to it as being both long-lasting and re-usable. Mike also mentioned sustainable resources as having a "positive impact" on the environment which could mean that their use would not result in environmental degradation and this second conceptual indicator (coloured green) was placed in *Caring for the Environment*. Both of these conceptual indicators related to the researcher's environmental theoretical component because of their reference to types of resources and their effects on the environment as well as looking after the environment.

The researcher created a new category for Mike's third conceptual indicator (coloured pink) entitled *Effects on Society*. This new category was necessary because Mike also made reference to the way that sustainable resource use also had to have a positive effect on society, which could mean people. This conceptual indicator related to the social component of the researcher's theoretical definition because it is referring to people and the way that their actions, in this instance resource use, impact on the environment.

His final conceptual indicator (coloured brown) was placed in the *Economics* category. It was placed there because of its reference to technology, and the way that technology enables people to make more efficient use of their environment and is usually related to economic activities. It related to the economic component of the researcher's theoretical component because of its technological reference.

While the most important concept that Mike learnt related to his post-workshop definition, it also showed evidence of his reflective approach to his teaching. He had reflected on his reasons for participation and realised that he had achieved his goal of learning what sustainability meant:

> *I think the most important thing that I've learnt is that three components of the environment, society and economy all works together and really … you can't have one without the other and they all flow into each other … that's the really big thing that I wanted to find out …* (Mike)

In this comment Mike demonstrated further complexity in his understanding of sustainability. Not only did he identify the three components of sustainability contained in the researcher's theoretical definition, he also discussed their interrelationship, which was not present in his definition.

Mike's self-rating of his understanding also increased over the course of the workshops going from *Reasonable* to *Good*. The shift in Mike's self-rating could be indicative of an increase in his confidence about his understanding. When using the researcher's scale, Mike's rating went from an initial rating of *Little* to *Very Good* at the end of the workshops.

He identified five sustainability issues in his initial questionnaire: recycling, building/construction, agriculture, marine environment and education. Apart from including agriculture again, Mike's post-workshop issues were different from those he initially identified. He included pollution, global warming, farming/agriculture, water supply and transport. On both occasions Mike identified sustainability issues by using one word. As stated previously, the researcher interpreted this use of one word to indicate a lower level of awareness of sustainability but, as also mentioned, it could be that Mike thought that only one word was required. However, the way that Mike identified four new issues in his post-workshop questionnaire could suggest that Mike has become more aware about the different types of sustainability issues around him.

Mike's identification of the diamond ranking activity as the most effective activity also appeared to be a choice that illustrated his reflective persona because he thought it encouraged thinking, or reflective processes:

> *I think the most helpful activity would be the grouping of the pictures, i.e. the diamond ranking … because you could actually see visually the different types of sustainability and the process of going from top to bottom … it was more structured … where yesterday's one [picture sorting activity] was more … scattered … it challenged your thinking.* (Mike)

Besides encouraging thinking, Mike identified the visual aspect of the activity as being important and also its structure. It could be that this activity challenged Mike's understandings of sustainability because the pictures showed different instances of sustainability, some of which he might not have considered. It could have also challenged his thinking because he had to rank his ideas about sustainability from most to least. Having to rank his ideas might have challenged his existing ideas, making him consider alternative perspectives and possibly led to a transformation in his ideas.

In summary, as a consequence of Mike's participation in the workshops, his understanding of sustainability appeared to develop in complexity to now include three components of the researcher's theoretical definition. Furthermore, when identifying the most important concept that he had learnt, Mike expanded on his definition, to include the interrelationship between the three components. Mike's scholarly and reflective approach seemed to be evident in his definition and in his choice of the most effective activity. His awareness of his understanding of sustainability also increased which could reflect his feelings of confidence about his understanding of this concept.

7.4.4 Using science to teach about sustainability

Mike also chose to teach EfS within the science learning area, a choice in common with many New Zealand teachers (Eames et al., 2008). Mike's initial planning for his Year 1 children aged

five to six years was based on the topic of life cycles of the monarch butterfly and plants. This planning was designed for the first term of the school year, February to April, approximately 10 weeks. However, Mike broadened his science teaching to include the topic of mini-beasts and consequently, the concurrent science topics ran for two terms in total through to June.

When Mike was asked why he chose the topic of a plant's life cycle, he gave a number of reasons. One reason was the availability of resources in the school, including his team's vegetable garden. He also mentioned his interest and knowledge about plants as well as his belief that the children did not seem to know a lot about plants. When asked how he thought sustainability might be incorporated into his planning, he said that he thought it would fit in well because there was more depth of learning available to the children than just plants when studying the garden:

> *It [the garden study] can be extended out … to not just the function of plants but also the wider environment of a plant …* (Mike)

Mike's comment about the available depth of learning could relate to the way that he aimed to challenge the children's learning. It also showed his understanding that plants had a role in a garden ecosystem. He then went on to explain that he had moved beyond just studying plants in the garden, his class were now also learning about the mini-beasts found in a garden, which was evidence of his awareness of interdependence. He also seemed to contextualise his understanding of sustainability within the garden to explain his reasons for including mini-beasts:

> *We've moved into mini-beasts so bringing those creatures that live in the garden, that whole eco-system and even what people do and their impact on the garden and it sort of goes round, people helping plants and plants help people. It sort of goes round in a big circle like that but it does extend out and get a bit bigger … it [the topic] just has sort of grown and grown and we have gone in an unexpected direction but that's fine. It's like the kids are driving the car and I'm just pointing the direction.* (Mike)

This comment illustrates Mike's use of a circle as a metaphor to explain sustainability in the garden with the idea of the relationship between people and plants going around with one helping the other. He also explained that the class had moved onto learning about mini-beasts as a natural progression of the garden study and the children's interests. This reason aligned with Mike's child-centred teaching style articulated in the previous section.

Mike did not provide a reason for his choice of the life cycle of the monarch butterfly. His class had moved on from studying monarch butterflies at the time of the first interview and Mike rarely mentioned the learning around this topic.

7.4.5 Planning for sustainability teaching: Awareness of its place in the curriculum

Mike planned cooperatively with other teachers in his Year 1 team but tailored his plan to incorporate sustainability. Mike's planning was based around the life cycles of the monarch butterfly and plants (Appendix R). There did not appear to be any planning for mini-beasts. Although there was no mention of the word sustainability in his planning, there appeared to be

potential for teaching this concept. Mike's planning contained five scientific understandings, one of which could be regarded as sustainability-related because of its reference to the interdependence between plants and people:

> *Plants benefit people and our environment*

In terms of links to *The New Zealand Curriculum* (MoE, 2007), Mike's plan included an achievement objective from a strand of the science learning area related to the taking of action entitled *Participating and Contributing* which states:

> *Students will explore and act on issues such that affect their lives and ask questions that link their science learning to their daily living.*

This choice of achievement objective can be regarded as related to sustainability because it makes reference to the taking of action, an essential part of an EfS programme (Tilbury, 1995). Mike's choice could have been related to his knowledge about sustainability in *The New Zealand Curriculum* (MoE, 2007) because when asked about the visibility of sustainability in this document, he said:

> *I think sustainability isn't a separate topic … [it] is something that is woven through different curriculum areas … mainly science … and health but it's also through technology and then of course literacy and numeracy come with that because you can use those tools to actually drive it, you know, as a medium … it definitely starts with science and technology but it can also go through art and language.* (Mike)

This comment showed that Mike was aware that sustainability should be infused through all of the learning areas, but he identified science and technology as being the starting points. When asked further about this, he said:

> *When I think of sustainability … science is the first thing that comes to mind because it is environmental … but it's only one of the principles [components of sustainability] … it's the main one that I probably associate with … as a teacher it's quite hard to teach Year 1 anyway.* (Mike).

This comment showed Mike's belief that the environmental component of the researcher's theoretical definition was the most important and the sustainability component that he thought was most appropriate for his Year 1 children.

Six learning intentions were constructed, one of which was sustainability-related and also directly related to a stated scientific understanding:

> *Recognise how plants are a benefit to people and our environment*

This learning intention was then linked to a learning experience entitled *Animals and plants are partners: What would it be like without plants?* It stated:

Discuss benefits of plants in our environment and some issues that arise. How can we help? Discuss ways in which plants contribute to Earth.

This linking of the scientific understanding, the learning intention and the learning experience seemed to have the potential for the teaching of sustainability because of their link to the interdependence of plants, the environment and people. However, there was no mention of assessing the children's understandings of sustainability.

7.4.6 Introducing sustainability: Capitalising on the 'teachable moment'

Mike adopted a constructivist approach at the start of teaching by brainstorming with the children to find out what they knew about plant classification, their structure and function, why plants are important to people and what would happen if there were no more plants. Based on their knowledge, Mike decided that the question that would guide their inquiry into plants would be: Why are plants important to us? This question seemed to have the potential to introduce sustainability because the children would have the opportunity to investigate the interrelationship between people and plants.

Mike introduced the concept of sustainability early in the programme. After doing the brainstorming activity, the children discussed parts of a plant and individually assembled a jigsaw of a plant that consisted of a flower, roots, stem and leaves. During this discussion Mike talked about sustainability and related it to prior learning:

> *We did speak about sustainability. It did go over their heads a little bit but we have just been doing a unit on the life cycle of a butterfly which goes around, as they said it goes around in a circle … so I used that as an example of sustainability and how it just keeps repeating itself … with the circle thing, it's about laying an egg and then hatching into a caterpillar and then making a chrysalis and it is called metamorphosis and then turning into a butterfly which lays an egg on a leaf which does the same thing and what they said was it just goes round in a circle.* (Mike)

Mike's comments showed the way that he used prior learning and the example of the monarch butterfly's life cycle to introduce sustainability. His explanation of how the life cycle went around continuously was also a contextualisation of sustainability. When asked why he chose to introduce sustainability in this way, Mike talked about the 'teachable moment':

> *Well we were actually doing it [the butterfly life cycle] at the time and through teaching it, it wasn't something I planned to do, it was just in the middle of teaching it, I just thought this is actually sustainability and I sort of stopped what I was doing and just changed course while I had their attention, so yes it was a really good opportunity to actually do that.* (Mike)

This remark showed how, in the middle of teaching about the butterfly's life cycle, Mike realised that the life cycle was an example of sustainability, thought it would be an ideal opportunity to introduce it and did so. It could be argued that this is evidence of Mike's constructivist pedagogy as he made links between prior learning and new ideas. It could also be evidence of his reflective

approach because it seemed to illustrate the way that he was thinking about what he was teaching as he did it. He also commented on how this realisation helped his understanding:

> *… it sort of informed me too. I think we over-think sustainability. It's always there but it can be quite hidden if it's not touched on or talked about. And the thing is it actually brings it out of the cupboard so to speak and you sort of realise that it actually does exist, we just aren't noticing it.* (Mike)

Mike's comment seemed to show his belief that sustainability was a hidden concept which could be related to its abstract nature. It could be that when Mike realised that the butterfly's life cycle was an example of sustainability, it helped to clarify his personal understanding of sustainability and helped him to "notice" it. This comment also illustrated Mike's reflective approach.

Throughout the teaching about plants and mini-beasts Mike continued to discuss sustainability with the children:

> *… it does all tie into sustainability, sustainability runs through it … it's like a theme so it's there anyway. You just sort of need to touch on it now and then to bring the kids back to why we're actually doing this and talk about it. They've got the basic idea of that as something that goes round or it's like a wheel, something that comes back all the time. Something that's forever, is long lasting … so we just need to build on that and take them as far as we can with their thinking about sustainability now they've got that basic idea …* (Mike)

Mike's statement showed the approach he was developing to the teaching of sustainability. This approach seemed to be one where sustainability was referred to as necessary during teaching to constantly remind the children and where developing an understanding of sustainability was the overall goal. This comment also illustrated that Mike had extended his repertoire of ways of explaining sustainability. Not only was he referring to sustainability as something that "goes round", he was now using the metaphor of a wheel as well as talking about sustainability as something that "comes back", goes "forever" and is "long lasting".

When learning about mini-beasts in the garden, Mike focused on snails. Initially he struggled with how to contextualise snails in terms of sustainability:

> *… I wanted to find out how does the snail play a part in that [the garden's ecosystem] so I can go from there. I wasn't too sure about exactly what the purpose of the snail was. I've always just seen it as a pest.* (Mike)

This remark seemed to highlight the importance of content knowledge. Without this knowledge Mike realised he was unable to contextualise sustainability and thus be able to teach about it, which could be further evidence of his reflective approach. However, after clarifying the role of snails Mike was then able to incorporate sustainability into his teaching about snails:

> *… if there wasn't any snails then what role does a snail play and the main one is that it's food for birds and so if there weren't any snails, there wouldn't be any food for birds so therefore there quite possibly wouldn't be any birds … or as many birds as there is*

> *anyway and therefore seeds would not be dispersed as easily. So it decreases the potential of growing plants and creating food. The food chain.* (Mike)

Mike's remarks showed how he talked about sustainability in terms of snails and the way in which he was able to incorporate the interrelationship between the snails, birds, plants and then people into his teaching. He also related this interrelationship to the children's everyday lives by discussing:

> *… that food doesn't just come from the supermarket, it does come from outside first … so it's sort of thinking outside their environment ...* (Mike)

However, Mike also discussed the difficulty of teaching about sustainability to this age group:

> *I'm finding that with the sustainability concept at this level it is very hard for them to grasp. It's about finding innovative ways they can really think about it so something as simple as that food chain because we've already established that it [sustainability] goes around or it's forever … just like everything in this year is so developmental so it's just an introduction really.* (Mike)

Mike's solution to the difficulty of teaching sustainability was to find contexts where the children were able to think about sustainability or in other words, ways of contextualising sustainability to which the children could relate.

He saw his teaching as introductory, a building of a foundation of understanding of sustainability. He also thought that the ideal time to teach about sustainability was that teachable moment because its use gave children lots of opportunities for learning about sustainability in different contexts and that by teaching in this way, he was catering for the diversity of learners in his class:

> *… that teaching moment,, that's probably the best time to do it [teach about sustainability], whether it's reading, writing or whatever learning area you are teaching, if you come across something and ah, stop the bus, let's use this as an example of sustainability … then it just gives you a variety of different examples in different situations that you can actually put to them, just to cater for different thinking patterns in different children and life experiences and cultures.* (Mike)

The ways in which Mike introduced and then taught about sustainability illustrated elements of Barnett and Hodson's PCxK (2001). For example, when Mike took advantage of the teachable moment, he used pedagogical content knowledge to introduce subject knowledge at the appropriate time to learners. Further examples of his use of this PCxK element was when he developed metaphors to teach sustainability and contextualised sustainability so that he made the concept of sustainability accessible for his learners. These examples also illustrate the way in which Mike was responsive to the needs of his learners.

Furthermore, it can be argued that in order for Mike to be able to capitalise on the teachable moment, use metaphors and contextualise sustainability, he needed to also use another element of PCxK, namely his academic and research knowledge. This element is concerned with knowledge about how and why people learn and in order to use metaphors, for example, Mike

would have had to have known about the way such a strategy assisted learning. Therefore, when Mike was introducing and teaching about sustainability, he seemed to be using a combination of these two PCxK elements.

Mike's account of his teaching also illustrated that the concept of sustainability appeared to have become very important to him in his teaching. This importance could be seen by the way that he thought that sustainability was a theme that could run through everything that was taught and that this approach offered a variety of ways in which the concept of sustainability could be learnt. Mike also thought that the key to developing children's understanding was to continually bring sustainability up in conversation. Additionally, he seemed to have an overarching goal in his teaching of sustainability, that of influencing the children to become "agents of sustainability". This phrase suggested that he wanted the children to become aware of sustainability in their lives so that they might incorporate sustainable practices and values. Finally, Mike seemed to have a science-focused view of sustainability that related to the environmental component of the researcher's theoretical definition. Although this focus did not correspond with his post-workshop definition that included all three sustainability components, he did justify his choice by saying that the environmental component was the most important and it was most appropriate for Year 1 children.

7.4.7 Teaching approaches to foster learning about sustainability

Mike used two teaching approaches to foster learning about sustainability, namely integration of learning areas and hands-on learning. Also, it could be argued that he did include an aspect of taking action in his EfS programme. These approaches related to Barnett and Hodson's (2001) PCxK elements of pedagogical content knowledge and classroom knowledge. As explained previously, fostering feelings of concern about the environment is an aim of EfS programmes (MoE, 1999) and Mike discussed how he included this type of teaching and the way he thought that the children had developed such feelings.

Mike helped his children to develop understandings of sustainability through integration of different learning areas. He talked about the way that he regularly took the children out to their team's garden and they all carried out tasks like planting seedlings and watering. Following their visits to their garden the children talked and wrote about their visits. Mike commented:

> *Today we went out and watered it this morning and then we came in and talked about it some more and what we did and wrote it. We wrote a sentence … a great resource to actually lead into their writing and reading …* (Mike)

Mike's remark illustrated how he was using their visits to the garden to not only develop scientific understandings but also their reading and writing skills. He appeared to view this use of discussion, reading and writing as important to develop both vocabulary and ideas:

> *I've been using [the] writing and reading programme as much as possible, just trying to find readers that are linked to the topic so they have those vocab words and also writing*

> *in it … especially during model writing [shared writing] we're actually talking and just using a lot of discussion and just sharing ideas and thoughts and experiences …* (Mike)

Mike also used visual arts to promote understanding and he described the story tree that was being constructed in his classroom:

> *… with visual art we are making along that big wall there, a garden and we have made petals, we've got leaves to go up. There's a post, the beanstalk and we can peg our published writing on the leaves so it's about the story tree or story vine and the children are going to make flowers for the garden. I think it's going to be a summer garden … we're making a mini-beast to go along with those to be stuck up in the garden.* (Mike)

In addition, he described how he had integrated science, maths, technology and sustainability through the design of a structure to hold up the bean plants in their team garden. The children had planted the bean seeds and watched while they germinated and started to grow. When the plants were put into the team's garden, Mike's classroom children constructed the tepee-shaped structure to support the growth of the beans:

> *… today we went out to the garden and we built it and erected it into the soil and planted [the beans] … and that was actually a really good experiment to tie sustainability, science, maths and technology all into that experience.* (Mike)

Mike provided experiences that linked the children's learning with the environment. As previously discussed, he regularly took his class out to care for their team's garden. These visits could have given the children opportunities to watch the plants grow, see their leaves grow, the flowers form and then the fruit start to grow and thus make connections between their reading and discussions and what they observed in the garden. Additionally, they had the experience of constructing the tepee-shaped frame to support the beans which could have added to their understanding of the needs of plants.

Mike also spoke about the time that his children harvested the potatoes, another example of learning outside the classroom. The children had gathered up all of the leaves from the potato plants and taken them to the compost bin. He took this opportunity to relate composting to sustainability:

> *We took them over to the compost and so that was a teaching moment, talking about the compost … I spoke about what's in the compost and all these branches and leaves and plants are going to rot away and decompose and turn back into soil which we will put back onto the garden to grow more plants … we sort of talked about worms and how worms eat it … that was enough and then they can just go away and think about that so when we're over at the compost next time I can bring that whole topic back up again …* (Mike)

Again, this seemed to be an example of Mike taking advantage of the teachable moment and being able to relate the children's experiences to the environment outside the classroom. This discussion that took place at the compost bin might have helped build the children's understanding of sustainability because of the way that Mike talked about the decomposition of

the plants, the way it turns into compost which can then be used to support the growing of more plants by improving the soil.

Mike's class took no direct actions. However, the way that he felt responsible for the team's garden and took the children out to tend the garden could be regarded as a form of action. His children planted, watered and then harvested the vegetables for the rest of his team which enabled many of the children to taste vegetables straight from the garden. Mike talked about the way that this gave some children an opportunity to taste vegetables that they might not get at home and also for the children to actually see where food came from. As a consequence, these opportunities might have helped some children build their understanding of sustainability.

Mike discussed this affective element in EfS and related it to the sense of ownership and guardianship that the children were developing about the garden:

> *We've been going out every second day … and watering the garden every morning … they will have a go at watering the garden and they've become part of that so they're realising that we need to take care of those gardens by watering it and tending to it … it's in the language that I use when we talk about it – it's our garden – and even when they're writing about the garden they use, they start our garden is green and our garden is tall and our garden has carrots and radishes and potatoes …* (Mike)

Mike's remarks seemed to indicate that the children had feelings of ownership towards the garden. He also thought that he had noticed the children were starting to think about caring for the environment. Mike gave this example about a discussion he had with the children about not being allowed on the grass during winter:

> *… we actually spoke about this [not going on the grass] this morning … they're not allowed to go on the grass because it's too wet and if everybody went on the grass, it would turn to mud and the grass would die and we wouldn't have any grass to play on, so we have to take care of our environment so it can keep on going.* (Mike)

His account of this discussion reveals that way that Mike was encouraging his class of children to develop feelings of concern for the environment and he also managed to incorporate one of his metaphors for sustainability "keep on going". His incorporation of the metaphor could be an example of the way in which he thought sustainability should continually be revisited as appropriate in the classroom programme.

Mike also talked about the way that he had noticed that many children's attitudes towards mini-beasts, such as snails and worms, had changed:

> *Beforehand they would all rush to just jump on it [a worm or snail] and stamp it out, it was like an enemy. Now they stop and think about it … maybe they shouldn't, fun as it is. I'm not saying it would be 100% but I have noticed a different thinking about it.* (Mike)

It could be that through their learning these young children now realise that mini-beasts are important because of their relationship to plants and people and thus part of their understanding

of sustainability. Consequently, they seemed to have developed feelings of respect for mini-beasts.

In summary, Mike made use of integration to teach about sustainability in a variety of ways which links to the PCxK element of pedagogical content knowledge (Barnett & Hodson, 2001). For example, he used oral language to discuss ideas about sustainability in the garden ecosystem. He utilised science, maths and technology to enable the children to design and build a tepee frame so that the bean plants could grow in the garden, which might have developed their ideas about sustainability and caring for the environment. During this teaching, Mike would have also used his classroom knowledge, another element of PCxK (Barnett & Hodson). As discussed previously, this element is knowledge that is particular to his classroom and learners and could have enabled him to give support as required to individual children to maximise effective learning.

Mike's teaching approaches also showed how he was making connections between learning and the environment outside the classroom for these young children. He gave them hands-on experiences in the team's garden and fostered feelings of concern for the environment by using his team's garden as a 'real life' example of sustainability. As the children were outside tending the garden, they were learning about the garden ecosystem and other related concepts, such as composting in an experiential manner. Mike also used this time as an opportunity to foster feelings of ownership for the garden, which could have led to the children developing feelings of concern for the environment.

7.4.8 Reflections on teaching

At the conclusion of his teaching, Mike reflected on his EfS programme. As previously stated, he thought that this programme had just been an introduction to sustainability for the children. Even though in his view it had been introductory, Mike still expressed the opinion that the children had developed an understanding of sustainability:

> *… just a little bit more knowledgeable about sustainability … and even using the word … and they use it in the right context so I'm figuring that they're actually understanding what they're saying..* (Mike)

He seemed to be confident that they would be able to take what they had learnt into their lives outside the classroom:

> *They can keep on doing [sustainability related activities] because they will come across those activities outside of school as well as inside of school so they're things that will just keep going. They will be able to see something they can do and be able to say I know how to do that … or I'm not going to stand on that snail now because now I know that they do actually play a part and I really shouldn't … and that's just something that keeps going through their life.* (Mike)

Mike had previously expressed the hope that he would be able to transform the children's thinking so that they acted in a pro-environmental manner. At the end of his teaching he said that he

thought that the children had become “little agents of sustainability” which suggested that he believed that he had achieved his goal.

7.4.9 Children’s learning about sustainability

Seven of the children in Mike’s class returned signed parental permission forms and gave assent to be interviewed which represented about one-third of Mike’s class. At the conclusion of the EfS programme, these children were interviewed individually by the researcher. The interviews started with the researcher showing the children two sets of picture cards. One set of cards depicted the life cycle of a bean plant (See Appendix P) and the other the life cycle of the monarch butterfly (See Appendix P). The researcher initiated a conversation with each child by asking them to put the plant cards in order. Once the child had placed the cards in order, the researcher asked questions about consequences of interruptions to the life cycle such as, “What would happen if the plant didn’t make any seeds?” The plant life cycle pictures were left in place and the child was invited to put the monarch butterfly life cycle pictures in place. Next the researcher asked similar questions about consequences of interruptions to that life cycle.

During this semi-structured interview, the researcher looked for evidence of these children being able to express a definition of sustainability similar to the one used by Mike; the ability to explain the consequences of an interruption to the life cycle of a plant or a butterfly and the ability to give an example of sustainability.

Table 7.3 presents the findings of the interviews with Mike’s class of children. Ticks were used to represent an instance. For example, if the child was able to state the taught definition, one tick was placed in the definition column. If the child was able to explain consequences of an interruption to the life cycle, a tick was placed in that column.

This table shows that five of the seven children were able to express a definition of sustainability similar to the one used by Mike in his teaching. One (MBS6) said that sustainability was like recycling bottles but did not elaborate further and the other (MBS3) was not able to express a definition. These five children used a variety of phrases to express their definition. For example MBS1 said:

> *It goes around and around and the same thing happens.* (MBS1)

Another response was MBS2’s:

> *It goes all over again.* (MBS2)

A further example was:

> *It goes round in a circle.* (MBS7)

Table 7.3 Mike's class of children's understandings of sustainability

Child	Expressed definition	Explained consequences of interruption to life cycle		Gave example of sustainability
		Plant	Butterfly	
MBS1	√	√		√
MBS2	√	√	√	
MBS3		√		
MBS4	√	√		√
MBS5	√	√	√	√
MBS6			√	
MBS7	√	√	√	√

Table 7.3 also shows that six out of the seven children were able to explain consequences of an interruption to the plant's life cycle. An example of this type of response was MBS2's and when asked what would happen to the plant if there were no more bees, they said:

> *They would die … we wouldn't have any plants … because plants grow from seeds.* (MBS2)

This response seemed to show that MBS2 understood that bees played a part in plant reproduction. Four of the children could explain the consequences of an interruption to a butterfly's life cycle and an example of this type of response was MBS6's. When asked what would happen if birds ate all of the caterpillars, he said:

> *There would be no butterflies … because birds ate the caterpillars … they turn into a butterfly.* (MBS6)

Such a response was regarded by the researcher as indicative of an understanding of the consequences of a life cycle interruption.

Three of the seven children were able to explain the consequences of life cycle interruptions to both a plant and a butterfly. MBS7 was one of these children and when asked what would happen to the plant if there were no more bees he said:

> *It would die … because there weren't any more bees to pollinate the flowers.* (MBS7)

When asked what would happen if there were no more seeds, he replied:

> *We wouldn't have any food or plants … because seeds make fruit and vegetables.* (MBS7)

While no connection had been made between pollination and the development of seeds, MBS7 seemed to understand the interrelationship between plants and bees and between plants and people. When asked what would happen if the butterfly didn't lay any eggs, they also seemed to show an understanding of the consequences:

> *There wouldn't be any more butterflies … no eggs were being born.* (MBS7)

When asked what might happen if there were no more caterpillars because the birds had eaten them all, this understanding also appeared to be extended to birds:

> *Caterpillars are special for the birds 'cause they need to eat the caterpillars so they could keep alive …* (MBS7)

This response showed not only an understanding of the consequences of life cycle interruptions but also of simple feeding relationships.

Four of these children gave examples of sustainability. Both MBS1 and MBS7 simply said that sustainability was like a circle. However, MBS4 and MBS5 gave far more complex examples. Not only did MBS4 understand the interrelationship between people and plants, she also gave an example of sustainability as something that goes round and round by describing the life cycle of a plant:

> *The old flowers that die have seeds in the middle and then they drop to the ground and then they grow all over again.* (MBS4)

When asked if she knew anything else that went round and round like that, MBS4 replied:

> *Butterflies. When the butterfly dies, they lay another egg … it cracks open again and it does the same thing … [the egg becomes] a caterpillar … becomes the butterfly.* (MBS4)

MBS5 also described the life cycle of the butterfly as something that goes all over again and when asked if she knew of anything else that went all over again, suggested rain:

> *Well the clouds get heavy with water 'cause they're made out of water, and then the rain drops fall and then the sun comes out. It soaks all of the rain drops up into the cloud and then it goes back again.* (MBS5)

These findings suggest that some of these children had developed understandings of sustainability with two of the seven being able to make a connection between the word sustainability and an example from their learning. One child had even made a connection between sustainability and an example unrelated to the topic taught. It must be noted, however, that despite Mike stating that the environmental component of sustainability was the most suitable for this age-group of children, their expressed definitions related to the temporal component of sustainability.

7.4.10 Mike's category of identity as a teacher of EfS: Intersection of personal life, professional life and personal beliefs

Taking all of these data into consideration and using the identity characterisation tool (p. 136), the researcher decided to place Mike in the *Complex* category. Although his sustainability issues were not contextualised, his post-workshop definition was researcher-rated as *Very Good*.

When asked if he had made any changes to his lifestyle decisions as a result of his participation in the workshops, Mike indicated that he already walked a lot, including to work, but said that he now gave more thought to the disposal of his rubbish:

> *… I'm a little bit more aware of recycling now … I'm sort of taking it even further now by really being quite fussy about what I throw out and where I throw it.* (Mike)

He thought that these practices impacted on his teaching:

> *It's something I can talk about to the kids about my practices, about being an environmentally friendly person … and how I do it … like a role model.* (Mike)

Mike also implemented sustainable classroom practices by having a recycling system in his classroom, promoting the Travel Wise programme and was taking responsibility for his team's garden.

When asked if incorporating sustainability had resulted in changes to his pedagogy, Mike replied:

> *I think I added another component to it so when we planned, we sort of incorporated it … sort of like woven through the learning outcomes and through the teaching of it you are constantly either bringing it into your lesson or referring back to it in your lesson … whenever I could because we were in the garden and it sort of always came back to why are plants so important and what would happen if we didn't have plants … because sustainability, I found, was quite tricky for them to understand.* (Mike)

These remarks seemed to show that Mike used sustainability as a theme and kept it at the forefront of his teaching on many occasions by making links between sustainability and the context of the garden. He also seemed to see it as an extra dimension to his teaching.

Mike said that he intended to continue including sustainability in his teaching:

> *I'll definitely include more of it and next time I'll teach it I'll be a lot more in the know and a lot more confident about doing it.* (Mike)

He also thought that teaching sustainability was important:

> *It's actually quite a powerful vehicle for teaching in general because you can incorporate it into anything and it's fun and it's purposeful and everyone can participate in it because it affects everyone … everyone is affected by living in the environment, so no-one is exempt from it … it's very cognitive … it gives them [the children] a chance to think about that it's something that affects them and they can be part of looking after their environment …* (Mike)

This comment seemed to show that Mike placed a high value on the teaching of sustainability because he felt that he enabled the children to think about the consequences of their decisions on their environment. Because environment affects everyone, he thought that learning about it catered for diversity and encouraged thinking.

Mike was also on the Enviro Curriculum Team. While he did not have a leadership role, he considered that it was his job to promote teaching about the environment. Additionally, Mike thought that he now included it more often in his teaching:

> *I'm a member of that group so therefore I'm like an ambassador of it. I think teachers who are rugby enthusiasts or soccer enthusiasts tend to wiggle that into their pedagogies … and so that definitely comes in and so we do tend to talk about the environment quite a lot more than I used to now.* (Mike)

Mike believed that his personal beliefs would always influence his teaching:

> *I guess as a teacher your personal beliefs and abilities always impact on your teaching in some way. You're not a robot.* (Mike)

He also acknowledged his ability to influence the children's ideas:

> *It was sort of my ideas that I put to them through my sharing … so it gave them something to go on. I mean, ultimately at the end of the day how they think about it is theirs, but I think I sort of need to influence it. Not overwhelmingly but I think you can't get away from that.* (Mike)

Mike said that he was comfortable exposing his beliefs and values to the children. However, Mike thought that he had a responsibility to acknowledge differing viewpoints and beliefs:

> *Although I need to share mine [beliefs and values] and it's a good platform for my teaching, you sort of have to realise that … other people might have different beliefs and why is that. So you have to take, within reason, their beliefs and values on board also and that's the responsibility that you have to realise that you have. That's the big part of how I personally am myself, is to not be so narrow minded or bigoted that I'm not open to discussion because that's the whole thing about learning as social human beings … if we're not open-minded then we might miss out on something that's quite important … we're sort of intelligent and responsible enough to know when something is not ethically or morally right.* (Mike)

This statement seemed to show Mike's belief that people's different ideas and values should be respected and that he felt he did this. It also seemed to show his faith that people are open to new ideas and able to distinguish between right and wrong. Although he never mentioned sustainability or environmental guardianship when he discussed these ideas, it could be that it was these ideas to which he referred.

Therefore due to the rating of Mike's definition, his incorporation of sustainable practices into both his home and school life, his view of himself as an ambassador of EfS, as well as the way he incorporated sustainability into his pedagogy and intended to continue to do so, the researcher placed him in the *Complex* category.

This interpretivist story has portrayed Mike as a person who has a scholarly and reflective approach to his pedagogy. This approach could be seen in the way that Mike could relate learning theory to his pedagogy, his use of inquiry and of reflection to improve his pedagogy and learning for his class of children. His reflective approach could also be seen in the way that he utilised the teachable moment, which illustrated the way that Mike seemed to be continually thinking about what he was teaching as he taught.

Mike's account also showed the way that his pedagogy had changed through his incorporation of sustainability. He now viewed sustainability as a theme to be woven through all of his teaching, discussed when relevant and not limited to just a science topic. He was also aware of his ability to influence his children's beliefs and by teaching in a way to foster the caring of the environment, aimed to have his children become "agents of sustainability". In these ways, Mike was constructing his identity as a teacher of EfS at Seaview School.

7.5 Chapter summary

This chapter has presented two interpretivist stories about the manner in which Hamish and Mike translated their understandings of sustainability into their pedagogy, its effects on their classroom children's learning and on their identities as EfS teachers. Even though they had different approaches to their pedagogy, there were similarities in their translations. Both Hamish and Mike used the four elements of Barnett and Hodson's (2001) PCxK, namely academic and research, pedagogical content and classroom knowledge. This use was evident when they identified the importance of science content knowledge and contextualisation when translating sustainability into their pedagogy. In addition, they both used integration and outdoor experiences as teaching strategies to enhance their children's learning about sustainability. There was some use of Barnett and Hodson's fourth PCxK element, professional knowledge evident in their planning.

However, there were also differences in their translations of sustainability. Both developed different approaches to teaching about sustainability. Hamish developed a simplified explanation of sustainability which he introduced near the end of his programme and related it to the science content knowledge taught. On the other hand, Mike introduced sustainability early in his programme by relating it to prior learning. He also developed a repertoire of metaphors to explain sustainability and took advantage of the 'teachable moment' to constantly re-visit sustainability throughout his programme.

Most of Hamish's class of children who were aged between seven and eight years could express the definition of sustainability taught to them but were unable to make links between the word sustainability and examples of it from their learning. All but two of Mike's classroom children aged five to six years of age could express a taught definition of sustainability and four were able to connect sustainability with examples from their learning. Two of Mike's class of children were able to give examples that were sophisticated for their young age.

Both Hamish and Mike identified the environmental component of sustainability as the one most appropriate for their children to learn about given their young age. However, when their classroom children's learning was analysed, the researcher found that these children's understandings of sustainability were related to the temporal component with no evidence of the environmental component expressed.

In terms of Hamish and Mike's identities as EfS teachers, their participation in the workshops and teaching of their EfS programmes appeared to strengthen their positions as EfS teachers at Seaview School. Both expressed increased confidence in their ability to teach EfS and also opinions that showed their perceived importance of teaching children about sustainability. In addition, both acknowledged the political nature of teaching by recognising that their opinions about the environment and their sustainable practices influenced others, their colleagues as well as children in their classes.

Chapter 8: Discussion

8.1 Introduction

This research project has focused on primary teachers' understandings of sustainability, a translation of these understandings into pedagogy and the measurement of its effects on children's understandings. The impacts of learning about sustainability on teachers' identities were also investigated. An examination of the related literature showed that there was no data to substantiate findings about New Zealand teachers' understandings of sustainability. The few international studies that used a framework for an analysis of primary teachers' understandings of sustainability, for example Spiropoulou et al. (2007), were limited in that they used a narrow range of sustainability components, that is environmental, social and economic. In addition, there were only a small number of studies where secondary teachers' understandings were analysed in terms of these three components of sustainability where it was found that the environmental component was the one most commonly identified out of the three (Summers & Childs, 2007; Summers et al., 2004 & 2005). There did not appear to be any research on how to develop teachers' understandings of sustainability.

There also seemed to be limited research on the effects of EfS professional development that has been substantiated by data on children's understandings. While some studies, for example Eames et al., (2010) and Christenson (2004) do mention student outcomes, the data is teacher self-reported. Additionally, there is little research into the pedagogical content knowledge (PCK) used by teachers to translate their understandings of sustainability into their pedagogy, making this concept accessible to learners. Kennelly et al. (2008) did investigate a beginning teacher's use of PCK but this was in an Australian setting and the teacher concerned had completed pre-service training in EfS, an opportunity that few New Zealand teachers experience.

It was suggested that transformative learning theory (Mezirow, 1990 & 2003) could explain the changes that might occur as the teacher participants learnt about sustainability. Mezirow regards such transformation as ontological change. However, there is very little research about learning that results in ontological change. Lange (2004) argued that her participants' views of the world changed as a result of an adult education course, but this course was related to coping with pivotal points in these adults' lives and not change that occurred as a result of developing an understanding of sustainability.

A teacher's identity with reference to EfS was also regarded as an important part of this research, however, there is little research into teachers' identities as EfS teachers. While Kennelly et al. (2008) made links between a teacher's prior personal experiences and her teaching of EfS, their study did not examine the effects of her understanding of sustainability on her identity.

As a result of these gaps in the research, the following research questions were investigated and will be answered in this chapter:

1. What are student and practising primary teachers' understandings of the concept of sustainability?

2. How can student and practising primary teachers' understandings of sustainability be developed?

3. How do the practising teachers translate their understandings of sustainability into their pedagogy?

4. How do the children in the practising teachers' classes express their understanding of sustainability following an EfS programme?

5. How does their understanding of sustainability affect student and practising teachers' sense of identity as EfS teachers?

The significant findings will be discussed with reference to these questions.

8.1.1 Chapter structure

The first research question is answered in Section 8.2 where the content of the student and practising teachers' definitions are discussed along with their awareness of their understandings. In Section 8.3 the development of the student and practising teachers' understandings of sustainability are addressed and the way in which this development took place is related to elements of transformative learning theory. How the practising teachers translated their understandings of sustainability in terms of their use of pedagogical context knowledge is discussed in Section 8.4. Section 8.5 answers the fourth research question related to the children's learning. The final research question is discussed in Section 8.6 where changes to the identities of the student and practising teachers as teachers of EfS are considered. The significance of this project's findings to the EfS research spectrum is addressed in Section 8.7. Implications for teacher education are discussed in Section 8.8, possibilities for future research are presented in Section 8.9 and in Section 8.10 limitations of this research are considered. The final section, Section 8.11, concludes the research project with a brief overview of the findings in relation to the research questions.

8.2 Student and practising teachers' understanding of sustainability

The first research question was: What are student and practising teachers' understandings of sustainability? The researcher considered this question to be important for two reasons. Firstly, having an understanding of sustainability is regarded as a foundation for EfS programmes (Nolet, 2009; Tilbury, 1995). It is also important because this thesis has argued that teachers need an understanding of sustainability in order to translate their personal understanding into their pedagogy so that it is made accessible for their learners – in other words their PCxK (Barnett & Hodson, 2001). However, as Jucker (2002) argues, many people (perhaps teachers) do not have a coherent understanding of sustainability. Therefore, the researcher decided to explore

teachers' understandings of sustainability prior to the workshops to ascertain their understanding of this concept.

In order to assess their understandings of sustainability and after consideration of the challenges around defining this complex and contested concept (pp. 14-20), a definition of sustainability was developed. This definition then enabled the researcher to measure the variety and levels of complexity of these teacher participants' understandings. The definition stated:

> Sustainability is made up of three interrelated components: environmental, social and economic. These components interact in ways that are unpredictable and co-evolutionary that effect further environmental change with unforeseen outcomes. Sustainability is a dynamic process but not the end point when working to resolve an environmental issue.

Two tools were developed to analyse the teacher participants' understandings of sustainability. The 'definition content analysis tool' (Figure 5.3 p. 93) allowed the researcher to analyse the content of the teacher participants' definitions of sustainability. The 'researcher's rating scale' (Figure 5.2 p. 92) enabled the researcher to judge the level of understanding expressed in the definition. The use of these tools facilitated a consistent and rigorous analysis of the data (Braun & Clarke, 2006) because the researcher had a set of criteria to follow and did not have to rely on personal decisions.

The findings of the research project suggest that initially these student teachers held a variety of simplistic ideas about sustainability with 52 out of the 77 using only one conceptual indicator in their definition (Appendix AC for details) (A conceptual indicator was a word or phrase that expressed a teacher participant's understanding of sustainability). Nearly half of their conceptual indicators related to the environmental component of sustainability (Table 5.1 on p. 87). These findings suggested that this complex concept is not understood by many in this sample group. Furthermore, their shallow and vague ideas could also reinforce Jucker's (2002) assertion that many people do not have a coherent understanding of sustainability.

The complex nature of sustainability was emphasised in that 61 out of 77 of these student teachers had an understanding rating of *None, Little* or *Reasonable* using the 'researcher's rating scale' (Figure 5.2 p. 92). Furthermore, a statistically significant number of student teachers' self-ratings of their understandings were different to researcher's ratings of their understandings with 10 student teachers over-estimating their understanding and 31 under-estimating (p. 102 for details). It is argued that self-awareness of one's understanding of sustainability could be seen as an example of metacognition as metacognition is one of four main aspects of constructivist learning theories. This aspect is considered crucial because people who utilise metacognitive strategies are more likely to be able to identify discrepancies in their thinking and make adjustments to their ideas (Skamp, 2008). This research has shown that 41, or over half, of these student teachers did not appear to have a self-awareness of their understanding and could be further evidence that this group was lacking a sufficient understanding of this concept.

Even the small sample of practising teachers who were enthusiastic and committed to educating children about caring for the environment expressed a simplistic definition. They also over-estimated their understanding of sustainability when compared to the researcher's rating.

Holding simplistic understandings of sustainability does not seem to be limited to New Zealand teachers because in Greece, Spiropoulou et al. (2007) also found that Greek primary teachers' understandings of sustainability were superficial. In addition, the findings from this study indicated that the most commonly identified component of sustainability in the teacher participants' definitions was the environmental component. This finding is similar to the findings of Summers and Childs (2007) and Summers et al. (2004 & 2005). In all of these United Kingdom studies, the environmental component of sustainability was the one most frequently identified even though these teachers were graduates with either science or geography degrees. It must be noted that all of these studies used an analysis framework that was limited to four components of sustainability – namely environmental, social and economic and their interrelationship, and there is a need to have a more complex framework that takes the temporal component into account as well. Because these New Zealand research findings were analysed using a more complex framework, these New Zealand findings emphasise the dominance of this environmental focus of most teachers (Spiropoulou et al., 2007; Summers & Childs, 2007; Summers et al., 2004 & 2005).

It could be argued that the ability to contextualise sustainability issues could signify the capability to transform an abstract global issue to a specific local context that relates to teachers' and children's lives. Consequently, an ability to contextualise an issue was regarded as recognition of people having a deeper level of understanding. In this research, both the student and practising teachers were asked to identify up to five sustainability issues and 66 of the student teachers and Mike (the teacher) gave one word issues in this question. Although it might have been that these teacher participants did not realise that more than one word was required, the researcher interpreted this use of one word as being unable to contextualise sustainability issues which was indicative of a lower level of understanding.

In answering the first research question, it would appear that the concept of sustainability is not understood in any depth as these teacher participants provided many examples of simplistic answers and demonstrated a lack of self-awareness of their understandings. Such findings indicate that there is a need to develop teachers' understandings of sustainability to enable them to translate their understandings into their pedagogies.

8.3 Development of student and practising teachers' understandings of sustainability

The second research question was: How can student and practising primary teachers' understandings of sustainability be developed? Twenty-one of the student teachers and the two practising teachers participated in a series of workshops designed to develop their understandings of sustainability.

The two tools developed to analyse these teacher participants' understandings of sustainability were used again to measure changes in their understandings (see Figure 5.2 on p. 92 and Figure 5.3 on p. 93). These tools enabled the researcher to analyse the content and levels of teacher participants' post-workshop definitions and compare them to their initial definitions. Based on this comparison, she was able to measure change and make decisions about the direction of such change.

The findings indicated that the majority of these student teachers' understandings of sustainability developed in complexity following the workshops. This development was shown by the way that seven out of 21 student teachers were able to include more conceptual indicators in their post-workshop definitions, 16 were able to include more of the researcher's theoretical components in their post-workshop definitions and 19 of the 21 student teachers' researcher-rated positions moved towards the *Very Good* end of the rating scale (Table 6.4 p. 122).

The practising teachers' post-workshop definitions also developed in complexity with Hamish and Mike (the teachers) including more conceptual indicators and theoretical components in their definitions. Their researcher-rated positions also moved towards to the *Very Good* end of the rating scale.

Despite these teacher participants' deepened understandings of sustainability and their increased awareness of that understanding, many of their post-workshop self-ratings still did not correspond with the researcher's rating. This finding provided further evidence that it is not easy to appreciate the dimensions and develop an understanding of this complex concept. For example, 15 of the student teachers and Mike under-estimated their post-workshop self-rating and Hamish over-estimated his. This finding suggested that developing an understanding and awareness of the dimensions of sustainability takes time and requires a high level of professional development.

Furthermore, following the workshops, more of these teacher participants were able to contextualise their identified sustainability issues, which is indicative of a deeper level of understanding of sustainability. For example, 12 of the student teachers and Hamish were able to provide examples of contextualised issues. This ability to contextualise issues could indicate that these teacher participants would be able to adapt abstract, global issues into ones that are local and relevant to children's lives when developing their programmes.

The workshop activities were designed to deepen teacher participants' understandings of sustainability and they appear to have done so (Table 6.1 p. 110). Teacher participants identified particular activities as being the most effective in developing their understandings and thus provided evidence of their ability to think metacognitively about their learning. In order of effectiveness, the consequence wheel, jigsaw, picture sorting and diamond ranking activities were the ones identified. The most commonly expressed reason for these activities' effectiveness was that they encouraged thinking. Some of the teachers' comments appeared to reflect their preferred pedagogical approaches – that being able to view pictures and manipulate materials

assisted them to reflect on their ideas. Another reason given for the effectiveness of these activities related to the discussions that occurred during or after the activities.

The development of complexity in these teacher participants' understandings of sustainability can be understood by considering Mezirow's transformative learning theory (1990). This theory has three elements, namely the construing of meaning, critical reflection and rational discourse. The first element is construing of meaning, where learners make a new or revised interpretation of the meaning of an experience – in this case their understanding of sustainability. Evidence of making new or revised interpretations of their understandings of sustainability could be seen when many of these teachers incorporated a temporal component into their post-workshop definitions or included the idea that sustainability is the interrelationship of three components: environmental, social and economic.

The second element in Mezirow's (1990) theory is critical reflection. It could be construed that these activities gave the teachers the opportunity to question their existing understandings about sustainability and provided an opportunity to explore an alternative viewpoint of sustainability that was presented to them. This exploration of an alternative viewpoint might also have been facilitated by the way that many of the activities were visual and required physical manipulation, for example the jigsaw activity. It could be assumed that during the course of the workshops, their questioning and exploration in the form of critical reflection might have led to the development of complexity in their understandings of sustainability.

The third element in Mezirow's (1990 & 2003) transformative learning theory is rational discourse which could explain the role played by discussion in the development of the teacher participants' understandings. Rational discourse is also referred to as communicative learning and Mezirow asserts that this type of learning takes place when a person engages in dialogue with others. While so engaged, they are assessing the authenticity and beliefs of others, arriving at a judgement about those beliefs in relation to their own. Such dialogue can be part of the critical reflection process and could have enabled these teachers to explore others' alternative perspectives of sustainability, which could lead to the development in complexity of their own understandings.

Therefore, when considering the second research question, it seemed that these teachers developed a more complex understanding and an increased awareness of sustainability following their participation in the workshops (Table 6.2 p. 114; Table 6.3 p. 118; Table 6.4 p. 122). This development could be explained through their engagement in particular activities which could be related to elements of Mezirow's (1990) transformative learning theory. The construing of meaning was shown in the way that their understandings of sustainability included new ideas. Particular activities such as the jigsaw puzzle appeared to foster critical thinking where the teacher participants had the opportunity to question their existing ideas and consider alternative viewpoints. Some of these activities encouraged rational discourse, where teacher participants

had the chance to explore others' ideas about sustainability in relation to their own ideas. In these ways their understandings and awareness of sustainability became more intricate.

8.4 Translating sustainability: Using pedagogical context knowledge in EfS teaching

The third research question was: How do practising primary teachers translate their understandings of sustainability into their pedagogy? Rather than exploring a teacher's developing pedagogy with a large group, it was decided to present an in-depth interpretivist analysis that provided details of practising teachers' developing understanding of pedagogy. It was hoped that this research data would provide a detailed, rich description of the enactment of their pedagogy.

Both Hamish and Mike chose to teach sustainability within the learning area of science – a choice commonly made by New Zealand teachers (Eames et al., 2008). This choice suggested that they viewed sustainability from a scientific perspective and their decision to teach the environmental component of sustainability supports this scientific perspective. It could be that these choices reflected the way that Hamish and Mike felt more confident and knowledgeable about teaching science and the environmental component.

In order to translate sustainability into their pedagogies and make this concept accessible to their classes of children, Hamish and Mike devised simplified explanations such as 'to keep on going', or metaphors such as 'a circle' to teach this sustainability concept. In addition, they both realised the need to contextualise the explanation or metaphor. While these explanations and metaphors did not contain the three interrelated components of sustainability, namely the environment, society and the economy, they did contain its temporal component.

The development and use of simplified explanations and metaphors to make the concept of sustainability more accessible to their young children is different to the findings of Summers and Kruger (2003). Teachers in the Summers and Kruger study were given specific concepts related to a particular interpretation of sustainability to use in their teaching programmes, such as 'taking responsibility' or 'making a difference'. The researchers' justification for giving teachers these concepts was that it gave teachers something more 'definite' with which to work. In this study, Hamish and Mike were able to use their personal understandings of sustainability to create something relevant, namely their own simplified explanations and metaphors, that were specific for their particular context and age group of children.

The timing of their introductions of the concept of sustainability to the children differed in the two programmes. Hamish introduced sustainability late in his programme which was focused on bees because he thought that the children needed content knowledge about bees and their interrelationship with plants and people before developing an understanding of this concept. On the other hand, Mike introduced sustainability early in his teaching about plants. He realised that he could link sustainability to the children's prior learning about the monarch butterfly's life cycle and took this opportunity. However, like Hamish, he also identified the necessity of content

knowledge when he planned his teaching about snails, when he realised that he needed to understand the role of snails in a garden's ecosystem.

Hamish and Mike's use and positioning of environmental content knowledge suggested that it could play an important part in EfS pedagogy. This finding reflects Skamp's (2009) argument that if teachers lack the environmental knowledge that is connected with the experiences being taught, they will not engage their children in those experiences. Furthermore, Hart (2010) asserts that without the prerequisite environmental knowledge of an issue, teaching about that issue will pose problems for teachers.

Mike also discussed how he foregrounded sustainability in his teaching so that it was not limited to the science programme. He described his use of the teachable moment when fostering learning about sustainability as well as relating sustainability to any other classroom discussions. Consequently, sustainability was a theme that ran through learning in Mike's classroom.

Barnett and Hodson's (2001) notion of pedagogical context knowledge (PCxK) can be used to explain how this classroom translation might have taken place. Their notion of PCxK includes four elements that interact and overlap:

- professional knowledge (knowledge gained about teaching through unconscious reflection and discussions with peers and is specific to a particular school)
- pedagogical content knowledge (knowledge about planning, teaching concepts and ideas and classroom management)
- academic and research knowledge (content knowledge and knowledge about how people learn often based on reflective inquiry)
- classroom knowledge (particular knowledge teachers have about individual learners in their class and ways of managing their learning)

(Barnett & Hodson)

Hamish and Mike's teaching of sustainability appeared to be a complex interaction between three of Barnett and Hodson's (2001) elements of PCxK and some inclusion of the fourth element. This interaction is shown in Figure 8.1.

Hamish and Mike's planning was evidence of their professional knowledge and pedagogical content knowledge elements. Their decision to incorporate the concept of sustainability into this choice of the science learning area provides evidence of the pedagogical content knowledge element as well as the academic and research knowledge element. Although they introduced sustainability in different ways, both had the opinion that given the complexity of this concept and young age of these children, the environmental component was the most appropriate component (pedagogical content knowledge; academic and research knowledge element, and classroom knowledge element). Furthermore, their development of simplified explanations or metaphors to

teach about sustainability and realisation of the need to contextualise the explanation or metaphor was evidence of their pedagogical content knowledgeas well as their academic and research knowledge.

The ways that they decided to introduce and teach sustainability also illustrated a complex interaction between three elements of PCxK, namely pedagogical content knowledge, academic and research knowledge, and classroom knowledge (Barnett & Hodson, 2001). Hamish's later introduction of the concept of sustainability because of his opinion of the need for content knowledge provided evidence of his use of pedagogical content knowledge, academic and research knowledge, and classroom knowledge elements. Mike's introduction that utilised prior knowledge as well as content knowledge also provided evidence of these three elements. His use of the teachable moment when fostering learning about sustainability also seemed to show Mike's use of all three elements.

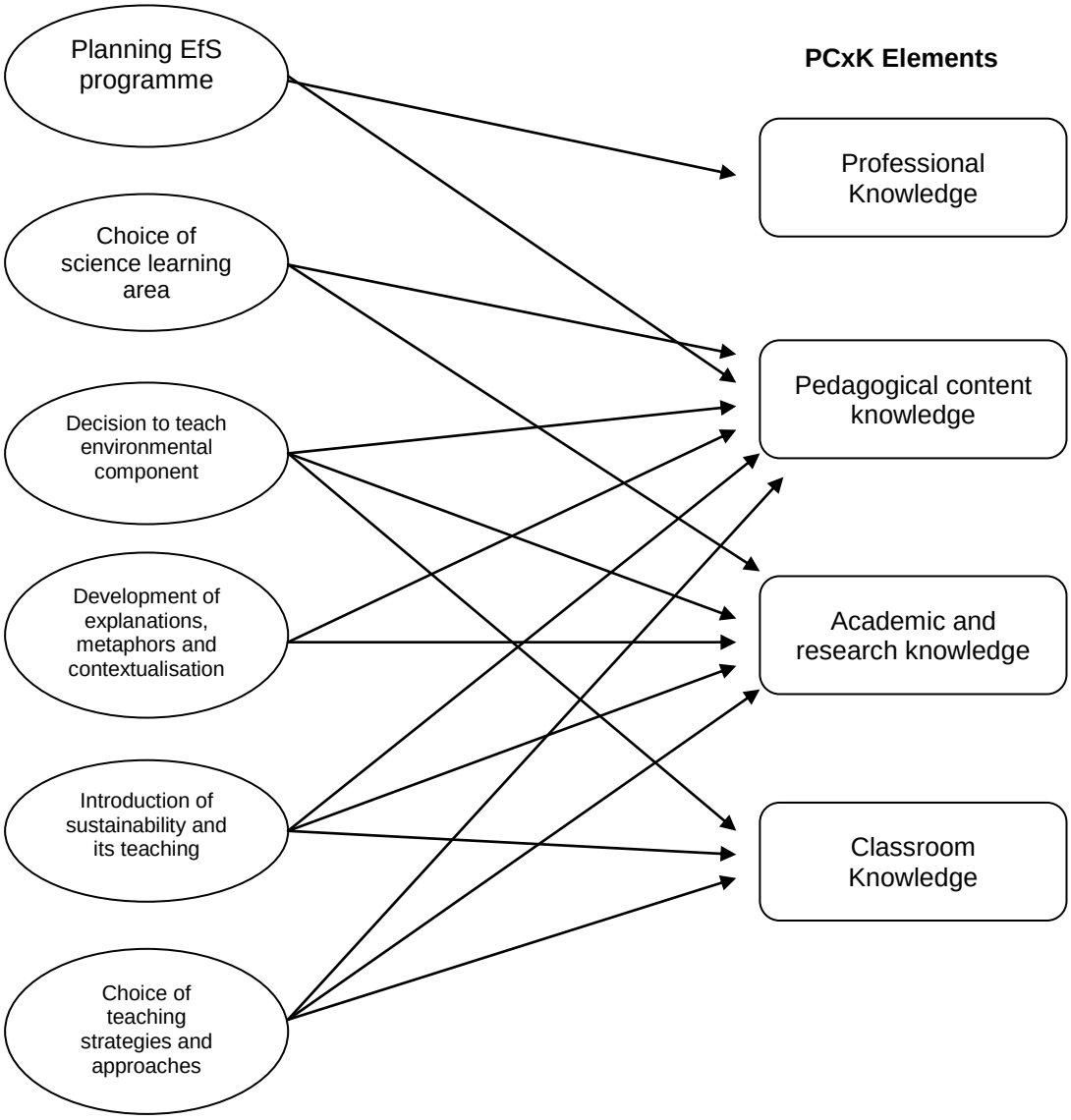


Figure 8.1 Interaction of PCxK elements used by Hamish and Mike to translate their understandings of sustainability into their pedagogy

This complex interaction of PCxK elements was also evident in Hamish and Mike's choices of teaching approaches and strategies. Both chose to integrate sustainability into other learning areas and provide opportunities for learning outside the classroom, which could be evidence of their pedagogical content knowledge, academic and research knowledge and classroom knowledge elements.

While the use of the elements of pedagogical content knowledge, academic and research knowledge and classroom knowledge were evident, there was little evidence of their use of the professional knowledge element. The only occasion when this element's overt use occurred was the utilisation of their science curricular knowledge when planning. In fact, Hamish and Mike's comments revealed little awareness of EfS curricular knowledge. There are possible reasons for the almost-invisibility of this PCxK element. Firstly, it could be that Hamish and Mike were unconsciously reflecting on their teaching of sustainability and developing a 'knowing' about it that was not articulated to the researcher. Its absence in the gathered data could also be explained by the way that so few teachers at Seaview were engaged in teaching EfS and there was little opportunity for discussion and consequent construction about professional knowledge around this area. Furthermore, because EfS is a relatively new area of learning, few teachers have had experiences with its teaching, which also could result in a lack of this type of knowledge.

This analysis confirms Kennelly et al.'s (2008) and Sherran's (2005) findings about the importance of pedagogical activities such as experiential activities outside the classroom and discussion in EfS. However, the significance of this analysis identifies the potency of using four particular strategies when teaching about sustainability. These strategies included simplified explanations and metaphors, contextualisation, content knowledge and use of the teachable moment. Firstly, these teachers demonstrated the effectiveness of simplified explanations and metaphors to teach a definition of sustainability, for example 'to keep on going'. Next they illustrated the value of contextualising sustainability where the examples come from the children's world such as using the school garden. Another aspect is the need for teachers and students to develop content knowledge. Not only did Hamish and Mike need content knowledge in order to contextualise sustainability, the children needed to develop content knowledge in order to construct understandings about sustainability. Finally, the use of the teachable moment seemed to provide a way of keeping sustainability in the foreground of learning during the EfS programmes. In these ways Hamish and Mike were able to use their deepened personal understandings of sustainability and relevant contexts to achieve a pedagogical realisation of their EfS programmes.

Therefore, when answering the third research question, it appears that for these teachers translating a personal understanding of sustainability into their pedagogy was a complex interaction between the three elements of PCxK: that is pedagogical content knowledge, academic and research knowledge and classroom knowledge with some use of professional knowledge (Barnett & Hodson, 2001). This complex interaction could be seen in the way that Hamish and Mike used their personal understandings of sustainability to devise simplified ways of

introducing sustainability to their classes of children, chose appropriate contexts and content knowledge as vehicles to teach this concept as well as a variety of teaching approaches.

8.5 Children's learning: The effects of translation of personal understanding

The fourth research question was: How do children in the practising teachers' classes express their understandings of sustainability following an EfS programme? At the conclusion of the EfS programmes, some of the children from Hamish and Mike's classes were interviewed individually to find out their understandings of sustainability. Picture cards were used as a starter activity (Appendices O and P) and semi-structured questions were used (Appendix N).

These young children had developed some understanding of sustainability that related to the explanations and metaphors used by their teachers. In terms of learning about the components of sustainability, the children's learning seemed to be related to the temporal component of sustainability but there was no evidence of learning related to the environmental, social or economic components. Although it might seem that there was some learning that related to the environmental component, the researcher decided that this learning was scientific in nature and did not include notions of environmental guardianship. For example, children in Mike's class learnt about the life cycle of a plant and there is evidence that they had feelings of ownership for their team garden, but none discussed that they were looking after the garden so that the plant's life cycle could continue uninterrupted, an understanding that the researcher regarded as an environmental one.

The researcher considered that an indication of having a good understanding of sustainability would be an ability to make links between the definition of sustainability and the scientific concepts taught. The children in Mike's class demonstrated this ability to link more strongly than those in Hamish's class. For example, two of Mike's classroom children were able to make links between the content knowledge they had learnt and the concept of sustainability. This finding suggested that most of the children's learning about sustainability was diffused into their science learning. This term 'diffused' refers to the way that the learning of the science concepts seemed to have overshadowed the learning about sustainability. An example of diffused learning was given when this child was when asked why bees were important:

> *They put pollen, like you have a flower and the bees get pollen all over them and then here's a flower and then it goes onto … from the stamens to the [stigma] … it makes babies … seeds … for to grow some more flowers.* (BCS11)

This response showed that BCS11 had a very good understanding of the pollination process for a seven year old. Her reference to pollination making seeds so that more plants could grow showed understanding of the life cycle of a plant. It could also be illustrating her understanding of the temporal component of sustainability. However, this child never made the link between sustainability meaning to keep on going (Hamish's simplified explanation) and the life cycle of the

plant continuing through the pollination process, resulting in diffused and possibly unrecognisable learning about sustainability.

If a teacher was focusing only on scientific conceptual learning, such learning would probably be regarded as indication of progress. However, the EfS programme was supposed to be an integrated one, where sustainability was the underpinning concept. Therefore, this diffused outcome was not anticipated.

These findings about the effects of Hamish and Mike's translation of sustainability into their pedagogies appeared to highlight the difficulties associated with the teaching of sustainability, especially for young children. Evidence of these difficulties was shown by the way that the children's learning about sustainability related only to the temporal component and sustainability understanding was diffused into science concepts. Further evidence of the difficulties of teaching sustainability was provided by the way that Hamish and Mike decided that the environmental component was the most appropriate for their children because of their young age. This finding suggests that when translating a challenging concept such as sustainability into pedagogy, teachers focus on the sustainability components that they find easy to understand and link to their lives. Hamish and Mike did seem to understand the environmental component because their post-workshop understandings of sustainability had an environmental-component emphasis that was shown in their definitions that contained conceptual indicators related to the environmental component. However, when developing their simplistic explanations and metaphors for teaching sustainability, it was the temporal component that was taught and not the environmental. Neither Hamish nor Mike seemed to be aware of this misalignment between intention and actual teaching. This lack of awareness could be further evidence of the demanding nature of the sustainability concept. Moreover, their decision to only teach one component could have under-estimated the children's ability and, it is suggested that with support, these children might have been able to develop emergent understandings of the environmental, social and economic components.

Besides being able to express an understanding of sustainability in terms of its temporal component, these young children also gained important understandings about environmental concepts that were sophisticated for their age (5-8 years old). For example, many developed an understanding of interdependence between plants and people or plants and their pollinators. This understanding of interdependence between people and plants could be argued to be an implicit understanding of the social component of sustainability because it provided the children with illustrations of the food production process. Through their learning about the role of bees and the life cycle of plants as well as caring for the gardens, these children learnt ways that their food was produced in that people, plants and other animals were involved and their food didn't just come from a supermarket. In this way, it could be suggested that the dislocation between these young children and nature was reduced (p. 4).

Consequently, because Hamish and Mike only planned to highlight one component of sustainability and were not able to draw these scientific and sustainability understandings

together, their translation of their understanding into their pedagogy seemed to result in a limited pedagogical realisation of their EfS programmes. However, they made a significant beginning to their learning about teaching the complex concept of sustainability. In addition, they were both enthusiastic about trying again and recognised the importance of teaching young children about sustainability.

There seemed to be little prior research with which to compare these findings. My previous research did show that 11-12 year old children could express understandings of sustainability in terms of environmental or social components of sustainability with a few being able to integrate these two components (Birdsall, 2005). However, the children in my study were older and the context studied was the local lake. It might be that age level does affect understanding and the context that I used afforded more opportunities for incorporating the different components of sustainability.

According to Timperley et al. (2007), the unexpected outcomes in the children's learning in this project are not unusual. They assert that a significant issue in professional development is that such development does not necessarily result in the desired effects on children's learning. In an attempt to explain the anomalies of outcomes in the children's learning, Desimone's (2007) research-based model for evaluating the outcomes of professional development will now be used to reflect on these findings.

Desimone's (2007) model proposes a theory of action where teachers firstly experience professional development containing five characteristics that results in the development of new knowledge and skills. They then implement these into their pedagogy which can result in improved children's learning. These characteristics and theory of action are situated within a nested system of complex factors such as the characteristics of teachers and children, the curriculum and leadership within the school (see p. 43). It is argued that an evaluation of professional development can take place by examining these characteristics and the theory of action. Hamish and Mike experienced all five characteristics in their professional development, namely developing subject knowledge; engaging in active learning; the new ideas were coherent with their currently held beliefs; a period of time was spent developing their understandings and supporting their pedagogy, and collegial discussions took place. They then incorporated these new ideas into their pedagogy. However, as discussed in this section, there were unanticipated outcomes in the children's learning and therefore, this professional development can be regarded as partially effective if evaluated just in terms of the children's understandings of sustainability.

This evaluation has shown that apart from children's learning, every characteristic and aspect of the theory of action were achieved. This leaves the nested system of complex factors to explore and it is proposed that these factors might have impacted on the pedagogical realisation of Hamish and Mike's EfS programmes. For example, in terms of teacher characteristics, Hamish and Mike were constrained by the time available for them to teach an extremely complex concept. Consequently, they could not teach everything and chose only to focus on one small part, which

could have under-estimated their classroom children's ability to grasp the complexity of this concept. In addition, these children were very young, aged between five and eight years of age, and their ages could have limited the development of their understandings. Furthermore, Seaview School has a diverse ethnic population, requiring teachers to develop children's English literacy skills. A corollary is that this focus also constrained the pedagogical realisation of their programmes.

The analysis above illustrates the value of Desimone's (2007) model. It enabled a step by step analysis, starting with the professional development programme, evidence of children's learning and consideration of nested complex factors. This analysis does indicate where a different focus needs to take place. It suggests that there was insufficient support provided for the planning and teaching of the EfS programmes. Such a finding suggests that the workshops needed to include more than developing understandings of sustainability and raising awareness of EfS pedagogy. Teachers need assistance in developing contexts so that simplified explanations and/or metaphors can be constructed for each of the components within the context being studied. In addition, there has to be development of ways of foregrounding sustainability, so that the focus is kept on sustainability learning and is not diffused into curriculum areas such as science, social sciences or health. Finally, Hamish and Mike did not seem to be aware of all of the ways that *The New Zealand Curriculum* (MoE, 2007) invites the teaching and learning of EfS. Therefore, professional development would need to involve an 'unpicking' of the curriculum so that the spaces for EfS can be made overt for teachers.

Therefore, when addressing the fourth research question, it appears that Hamish and Mike's translation of their understanding of sustainability into their pedagogies did have an effect on their children's learning with many being able to express an understanding in terms of sustainability's temporal component. Even though only a small sample of children was studied, these findings are only the first building blocks in our understanding about how children learn about sustainability. In addition, many of these children developed understandings about interdependence between plants, animals and people that were sophisticated for their young age. However, their translation illustrated the difficulties of teaching this multi-faceted concept, such as learning about sustainability that was diffused into science and a misalignment between intention and actual pedagogy. Finally, the findings related to this research question emphasise the need for triangulation of the pedagogical development of teachers using children's understandings as a means of monitoring the growth of teachers' pedagogy. They also highlight the value of Desimone's (2007) model for evaluating the outcomes of professional development.

8.6 Development of identity as a teacher of EfS

The final research question was: How does their understanding of sustainability affect student and practising teachers' sense of identity as EfS teachers? An 'identity characterisation tool' was developed by the researcher to categorise these teacher participants' identities (see Table 6.6 on p. 136). It was developed using a variety of data (see p. 135-6) and enabled the researcher to

place each teacher participant in a category related to their identity as an EfS teacher. Four categories of identity were developed with *Naïve* at one end, then *Emerging* to *Developing* and finishing with *Complex*.

The findings of this project suggest that at the conclusion of the workshops, student teachers' identities as teachers of EfS were affected by their understandings of sustainability. For example nine student teachers were placed in the *Developing* category (second most sophisticated category in the tool), eight in the *Emergent* and four in the *Naïve* category of the identity characterisation tool. At the end of their EfS programme, Hamish and Mike were placed in the most sophisticated category of *Comple*x.

Firstly, this section will relate the development of these teacher participants' identites as EfS teachers to Gee's (2001) identity perspectives. Then the complicated interrelationship between understandings, professional and personal beliefs and identity will be used to explain the way that, despite participating in the same series of workshops, these teacher participants were placed in different identity categories.

In terms of Gee's (2001) four identity perspectives, it could be said that these student teachers had developed their A-Identity, or affinity perspective. Choosing to participate in the workshops and engaging in those particular activities would have given this group of student teachers a common interest and the opportunity to construct their A-Identities. However, there was no opportunity to construct an I-Identity or institutional perspective, because these were student teachers, yet to be employed as teachers in a school. Additionally, there was little opportunity to build a D-Identity or discursive perspective, because of the lack of both time and opportunity to engage in discourse and dialogue with other people outside of the group that would have given recognition to this identity perspective. But once these student teachers are employed in a school and, if they choose to incorporate sustainability and resource management systems in their classrooms, they could be in a position to construct these two identity perspectives both consciously and unconsciously.

Hamish and Mike already had an I-Identity (Gee, 2001) conferred upon them as teachers at Seaview School. Also, they had D-Identities as teachers because their community and society recognised them as teachers through their discourse and actions. From the limited data collected, as a result of teaching their EfS programmes, their D-Identities are presumed to have changed because their community could now talk about them in ways that reflected their incorporation of sustainability into their classroom programme. As members of Seaview's Enviro Curriculum Team, Hamish and Mike already had an A-Identity related to their membership (p. 163 and p. 184). Following the workshops, their A-Identities have strengthened due to their engagement in the activities because both were enthusiastic about teaching further EfS programmes.

The findings of this project seemed to show that there is a complicated interrelationship between understandings, professional and personal beliefs and identity. This complicated interrelationship

was reflected in the student teachers' placement in different identity categories. This range of identity categories could indicate differences in change of knowledge construction and worldview related to their learning about sustainability. Those student teachers in the *Developing* category could have experienced ontological change, in other words a change in the way that they viewed the world. According to Mezirow (1990), this type of change is the goal of transformative learning theory. They might now be interpreting their world in relation to their more complex understanding of sustainability and developing their pedagogy through the lens of sustainability. On the other hand, while those eight student teachers categorised as having an *Emergent* EfS identity did appear to have experienced a change, their workshop experience did not appear to have had such a profound effect as on those in the *Developing* category. It could be presumed that the four teachers placed in the *Naïve* category did not experience any ontological change despite their engagement in the same activities. While their awareness of sustainability had grown, they did not seem to see sustainability as a priority to be taught and discussed in their classrooms. Taylor (2007) notes that people need to be receptive to transformative experiences and want to change and it could be that this particular group were not inclined in this way at that point in time.

Professional beliefs are part of this complicated interrelationship and subject affiliation is regarded as a powerful part of a teacher's identity (Enyedy et al., 2006; Helms, 1998). In addition teachers tend to teach what they are passionate about (Kennelly et al., 2008). It is possible that when the *Developing* group was learning about sustainability, they developed a passion for teaching EfS and consequently felt a strong affiliation to it, potentially influencing their choice to include it in their classroom programmes. Therefore this affiliation could have become a strong part of their emerging identities as teachers. Evidence of this group's passion and affiliation for EfS can be found in their intention to include sustainability in their classroom programmes as well as incorporating sustainable practices into their professional lives. Some even expressed the belief that their teaching could influence their children's environmental beliefs and actions, for example Briar, Lily, Alyssa and Violet. Subject affiliation and passion for teaching EfS did not seem to be as strong in the *Emerging* group who seemed to place some importance on raising children's awareness of sustainability or implementing classroom waste management systems. Student teachers in the *Naïve* group demonstrated a very weak affiliation to EfS by stating their awareness of implementing sustainable classroom practices or possibly teaching about sustainability.

Furthermore, because primary school teachers are not specialist teachers, they are likely to have multiple identities, referred to as sub-identities, with some more central than others (Beijaard et al., 2004) which could also explain this complicated interrelationship. For those student teachers categorised as *Developing*, it could be argued that their sub-identity as an EfS teacher might have become central to their professional identity whereas those in the Emerging category could have a potentially subordinate EfS sub-identity and those categorised as *Naïve* having an EfS sub-identity at the extreme periphery of their overall identity as a teacher.

The connection between teachers' personal and professional lives is also related to identity (Thomas & Beauchamp, 2011) and also illustrates this complicated interrelationship. For example those student teachers categorised as *Developing* reported that they already included sustainable practices in their personal lives and/or had decided to make changes to include more sustainable practices could be indicative of such a connection. On the other hand, student teachers in the *Emerging* category reported some inclusion of personal sustainable practices and those in the *Naïve* category mostly indicated their awareness of such practices.

While the student teachers appeared to be developing their identities as EfS teachers, Hamish and Mike already had identities as EfS teachers because of their membership of the Enviro Curriculum Team. In their cases, the complicated interrelationship between understanding, beliefs and identity appeared to be expressed in a strengthening of their identities as EfS teachers.

Hamish and Mike did not appear to undergo ontological change as a result of their participation in the workshops. Both teachers already seemed to incorporate an environmentally-friendly approach in their classrooms, such as waste management systems and promoting Seaview's Travel Wise programme. Hamish had existing strong connections between his personal and professional life in terms of his sustainable lifestyle practices. Mike appeared to strengthen his connections by incorporating more such practices following the workshops. It appeared that their understandings of sustainability developed in complexity and their sub-identities as teachers of EfS seemed to become more central to their professional being (Beijaard et al., 2005). Evidence of this centrality can be seen in the way that Hamish and Mike developed strategies to introduce and teach about sustainability and intended to incorporate it in their future teaching. In addition, their learning about sustainability seemed to give them confidence to incorporate it into future EfS programmes and resolve issues around the teaching of this multi-faceted concept to young children.

While Kennelly et al. (2008) also found that a teacher's personal life had connections to their professional life, thus legitimising the incorporation of their personal environmental beliefs into their EfS pedagogy, the results of this study seem to show that a teacher's EfS identity is more than personal belief. Hamish and Mike's understandings and professional beliefs, such as subject affiliation also seemed to affect their EfS identities.

These findings suggest that simply developing a more complex understanding and awareness of sustainability is not enough to result in a change to teachers' identities as EfS teachers. Empowering teachers to teach EfS must be more than developing knowledge. Professional learning and development opportunities must aim to effect ontological change and subject affiliation.

Therefore, when answering the final research question about the effect of a teacher's understanding of sustainability on their identity as an EfS teacher, it seems that a teacher's growing understanding can have an effect, but in different ways, thus illustrating the complicated

interrelationship between understanding, beliefs and identity. Evidence of this complicated relationship could be seen in these student teachers' different levels of ontological change, their varying amounts of passion and subject affiliation for EfS, the extent of centrality of their EfS sub-identity and the degree of connection between their personal and professional life expressed through their personal sustainable practices. The two practising teachers, Hamish and Mike, already seemed to have formed a sub-identity as EfS teachers. The development in the complexity of their understandings of sustainability seemed to result in their sub-identity becoming more central and also seemed to give them the confidence to incorporate sustainability into their pedagogy with the intent of continuing to do so in the future.

Consequently, it appears that a teacher's ontological position is of great significance when teaching EfS programmes because teachers have to be able to see where sustainability fits into their world. But developing an understanding of sustainability, which seems to have an impact on one's ontology, is difficult because it is a complex concept. Therefore, when designing teacher education programmes, activities need to be included that promote ontological change because without such change, effective teaching of EfS is unlikely to occur.

8.7 Significance of this research to the EfS research spectrum

This research project makes two contributions to research in the area of education for sustainability:

- the construction of tools to both analyse and measure understandings of sustainability and identity as an EfS teacher
- knowledge about the complexities of teaching EfS

Each contribution will now be discussed.

8.7.1 Construction of tools

The first contribution is the construction of three tools. The first two tools enabled the researcher to analyse, compare and measure the content and level of these teacher participants' understandings of sustainability. The first tool was the 'researcher's rating scale' (Figure 5.2 p. 92) and the second was the 'definition content analysis tool' (Figure 5.3 p. 93). The researcher developed these tools when analysing the student teachers' self-ratings of their definitions of sustainability because she noted that some of the student teachers' self-ratings did not correspond with how she would have rated these definitions.

The tools were constructed using the categories used to code the student teachers' conceptual indicators, or ideas they had expressed about sustainability, as well as the definition developed by the researcher for this project (see p. 24). The first tool, the 'researcher's rating scale' (Figure 5.2 p. 92) was constructed inductively to correspond with the five point rating scale used by the teacher participants to self-rate their understandings of sustainability. By relating the categories based on the student teachers' conceptual indicators to the five components of the researcher's

definition of sustainability (environmental; social; economic; temporal; and the interrelationship between environmental, social and economic components), the researcher was able to develop a model to identify levels of understanding of the concept of sustainability.

In order to triangulate these levels on the 'researcher's rating scale', another tool was developed. This tool, entitled the 'definition content analysis tool' (Figure 5.3 p. 93) was deductive in nature and was based entirely on the components in the researcher's definition of sustainability. Firstly the researcher used a count of the components in the definition, namely environmental, social, economic and temporal. After trialling this configuration of components, she realised that it did not capture the complexity of the definitions and that a two-dimensional configuration was needed. The researcher added a three-point vertical scale to capture complexity of the components in a definition. Then the researcher considered the way in which some definitions identified the interrelationships between components and therefore, a further component was added together with a vertical scale to capture complexity. The final configuration of the data analysis tool that consisted of five components and three levels was then tested by the researcher and by two of her colleagues using data generated during the student teachers' workshops. This process brought a level of consistency and rigour to these instruments (Braun & Clarke, 2006) which enabled the researcher to consistently analyse and measure the content and level of the teacher participants' understandings of sustainability.

These tools were also used to measure changes in the teacher participants' understandings of sustainability following the workshops. Their consistency enabled the researcher to measure change not only in the teacher participants' understandings of sustainability but also change in their awareness of their understanding.

However, these two tools appear to have limits. These tools can only be used to measure understandings of sustainability and are not able to measure other types of learning, for example the children's learning about an organism's interdependence. Furthermore, the 'researcher's rating scale' was inductively developed and based on this particular group of teachers' expressions of sustainability. Other groups of people might have different expressions, requiring further refinement of this tool.

These two tools could be used in further research or teaching, either by the researcher or by others. For example, the tools could be used by teachers to measure the effectiveness of professional development since they have the facility to foster metacognitive thinking when used at the beginning of such programmes and repeated at the end to examine any changes. Teachers could also use these tools in their planning and teaching to ensure that all of the components of sustainability were covered. In addition, teachers could use these tools to assess their students' understandings of sustainability, but are probably more appropriate for older children or when all components of sustainability are taught. Then teachers could develop assessment rubrics based on the tools to show the levels of understanding about sustainability and also progression of learning in their students.

A third tool was developed by the researcher in order to characterise teacher participants' identities. This tool, entitled the' identity characterisation tool' (Table 6.6 p. 136), was developed deductively and provided a snapshot of the teacher participants' identities as teachers of EfS. This tool has four categories of identity: *Naïve*, *Emergen*t, *Developing* and *Complex*. Criteria for each category were developed from aspects of identity theory and theory about the relationship between knowledge and action-taking. A range of data was also taken into account (p. 135-6) and this use of multiple data sources enhanced the trustworthiness of the findings and analysis (Merriam, 1998).

The identity characterisation tool allowed the researcher to examine each teacher participant's expressed understandings and awareness of sustainability as well as their personal and professional beliefs to make a judgement about their level of identity as an EfS teacher. Similarly, the identity characterisation tool enabled consistent analysis of data because of its set criteria being used on each occasion, leaving little room for personal opinion.

However, this identity characterisation tool has limitations in that it does not directly measure ontological change, only manifestations of such change. When considering the significance of ontological change to bringing about a desire to teach EfS programmes, there is a need for developing a way of measuring such change.

This tool has the potential to be used by other researchers interested in exploring the role of identity in EfS teaching. Additionally, it has the potential to also foster metacognitive thinking when used by teachers at the beginning and end of professional development programmes to measure their evolving identities as EfS teachers.

8.7.2 Knowledge about the complexity of teaching EfS

The second contribution to EfS research made by this research project is knowledge about the complexity of teaching sustainability. Teaching about sustainability does not seem to be a process of simply acquiring knowledge and skills and then teaching these to children. Nor does it lend itself to an easy, reductionist unpicking. Instead teaching sustainability appears to be a complex intersection of understanding, professional and personal beliefs and identity.

Developing an understanding about sustainability is an important part of this intersection. The reason for its importance is that learning about sustainability can bring about an ontological change (Mezirow, 1990) where a teacher starts to view both their personal and professional lives through the lens of sustainability. Examples of this type of change can be seen in student teachers who were placed in the *Developing* category of the identity characterisation tool. As their understanding of sustainability became more complex, it impacted on their conscious intention to incorporate sustainability and sustainable practices into their classroom pedagogy (Epstein, 2007). It also led to some of them making changes to more sustainable practices in their personal lives. Furthermore, some of this group grew to see themselves as being able to influence their children's ideas about sustainability. This finding is similar to Lange (2004) who

found that her participants experienced ontological change when they shifted their perspective to a people focus rather than a focus on material possessions.

However in this research, developing more complex understandings about sustainability did not always seem to lead to such a change. For example, three of the four student teachers in the *Naïve* category developed more complex understandings, but did not express an intention to incorporate sustainability or sustainable practices into their pedagogy. In addition, Hamish and Mike's understandings of sustainability developed in complexity, but they also did not appear to undergo ontological change. This lack of change could be due to the way that notions of sustainability had already permeated Hamish and Mike's personal and professional lives. Instead, through their participation in the workshops and sustained support from the researcher, they developed confidence to teach and resolve issues about teaching this complex concept to children aged between five and eight years of age.

The coherence between personal and professional beliefs (Thomas & Beauchamp, 2011) was also an important part of this intersection. Like the teacher studied by Kennelly et al. (2008), Hamish and Mike held pro-environmental beliefs that stemmed from their life experiences, both as children and adults. These personal beliefs impacted on their pedagogy in various ways. For example, both Hamish and Mike had parents who gardened and this childhood experience influenced their pedagogy, with Hamish offering gardening advice to other teachers and Mike taking responsibility for his team's garden. Another example was the way that Hamish and Mike incorporated sustainable practices into their personal lives and carried these practices into their professional lives, acting as role models through their support of the various waste management and travel programmes running at Seaview.

Kennelly et al. (2008) found that their teacher's personal pro-environmental beliefs empowered her to legitimise these beliefs and incorporate them into her teaching. This study reinforces their finding as both Hamish and Mike seemed to have legitimised their personal beliefs and incorporated these into their pedagogies. Evidence of this legitimisation could be seen in the way that Hamish and Mike purposely fostered the development of feelings of concern for the environment in their children. Furthermore, they both believed that it was important to teach children about caring for the environment. Consequently, they did not perceive their teaching as value-free and were happy to expose their personal beliefs to their classes of children but in a way and at a level that was appropriate for these children's ages.

It is difficult to comment on whether these student teachers' personal beliefs had an impact on their EfS teaching because they had yet to begin their teaching careers. However, given that those in the *Developing* category of the identity characterisation tool either already practised and/or decided to incorporate sustainable practices in their lives, it is predicted that their beliefs could have an impact on their teaching in the future.

The final part of this complex intersection is a teacher's identity and it appears to be the most complicated part. As a result of this study, it is the researcher's opinion that identity in EfS seems

to be an amalgam of one's personal and professional lives, beliefs and knowledge. In terms of one's personal life, it appears that a person with an identity as an EfS teacher brings to his/her teaching experiences that engender feelings of attachment to the environment and a desire to protect it. One's sustainable lifestyle practices could be regarded as indicative of these personal feelings and such practices seem to transfer into their classroom environment. As part of such a teacher's professional life, a teacher of EfS also brings their personal beliefs into their teaching and some perceive themselves as role models for their children. The way that teachers of EfS bring their personal practices and beliefs into their pedagogy creating coherence between their personal and professional lives seems to be an illustration of Clandinin and Connelly's (1995) professional knowledge landscape.

Identity development in EfS also seems to be an on-going process (Beijaard et al., 2004). By transferring their personal practices and beliefs into their professional lives and through their learning about sustainability, a teacher of EfS seems to develop a stronger affiliation for this type of learning (Helms, 1998) and could become a member of a group that also practises EfS (Wenger, 1998). Such membership appears to offer opportunities for discussions with like-minded teachers. This process of affiliation and membership seems to reinforce identity as an EfS teacher, strengthening their identity and giving such teachers confidence to implement EfS and resolve any issues around its teaching.

To further complicate the teaching of EfS, the findings from this study also show that there is more than one way of implementing EfS programmes. Such a finding illustrates the complexity of EfS teaching and the way that a teacher's understanding, personal beliefs and identity intersect. Hamish was a nurturer of both the environment and his children. His nurturing qualities could be seen by the way that he assisted other teachers with their gardens and was leading the creation of a bee-friendly garden at the school. It could also be seen in his concern for the development of English literacy in the children in his class. His understanding of sustainability and awareness of the differing needs of his children were integrated into his teaching programme. Mike, on the other hand, had a more scholarly and reflective approach. His pedagogy was more sophisticated in that he related his pedagogy to theory, reflected on his decisions and discussed his pedagogy with others. Mike took advantage of the teachable moment to both introduce and teach about sustainability, and in line with his child-centred approach, discussed sustainability at appropriate moments during learning. He also challenged his children's learning with ideas that were above their current level in the belief that such ideas would encourage thinking and would eventually become the children's own.

Therefore, I assert that the teaching of EfS is a complex intersection of understanding, personal and professional beliefs and identity and is an on-going process. Any professional development programme in EfS would need to address all three parts in order to result in effective children's learning in this area.

In terms of the EfS spectrum of research, this study has provided some insights into the environmental learning processes of children and their teachers. Despite the small numbers of teacher and child participants, together with the way that one example of two teachers' responses have been monitored and analysed, it has provided a fine-grained examination of the complexities involved in environmental learning processes. The findings suggested that developing an understanding of sustainability is difficult due to its complicated and abstract nature. Furthermore, the issues involved in translating one's understanding of sustainability into one's pedagogy in a manner that results in children developing an age-appropriate understanding of sustainability, is fraught with difficulties.

These findings have implications for teacher education and many possibilities for future research. These implications and possibilities will now be discussed.

8.8 Implications for teacher education

The findings of this research project have implications for both pre-service and in-service teacher education. This research has shown how demanding it is to teach and learn about sustainability due to its complex and abstract nature. Therefore, finding ways to overcome these challenges are necessary.

One implication for teacher education is to develop both pre-service and professional development programmes that will foster teachers' understandings of sustainability. Ideally, this development will result in ontological change so that teachers' understandings of sustainability affect both their professional and personal lives. This project's findings suggested that ontological change is crucial to the teaching of EfS programmes. In addition, such professional development needs to include triangulation in the form of data about resulting children's learning so that its effects can be monitored closely. The value of this type of triangulation was illustrated in this project by the use of Desimone's (2007) model.

This need for ontological change in professional development was evident when both Hamish and Mike spoke about the way that generalist primary teachers had a 'passion' for particular learning areas, like rugby or music and tended to focus their teaching more on their area of passion, a view echoed by Kennelly et al. (2008). As a result, according to Hamish and Mike, those teachers at Seaview School not particularly interested in environmental issues saw EfS as something extra to include in their already full classroom programme. This view of EfS as being an 'add on' for New Zealand teachers is confirmed in Eames et al.'s (2008) research and would also need to be addressed by EfS professional development.

In addition, developing an understanding of sustainability needs to enable teachers to develop contexts for the learning of sustainability that are relevant and appropriate for the age level of their classes of children. Another implication is the need for assistance to choose appropriate contexts that afford opportunities for all of the components of sustainability to be taught. Teachers then need help developing ways to teach about each of the components within the context chosen,

perhaps by identifying a metaphor or simplified explanation. Furthermore, teachers have to know how to foreground sustainability so that learning is not diffused across other learning areas, such as science, social sciences or technology.

A further implication for teacher education is the need for teachers to engage in curriculum analysis so that they can identify the spaces for teaching and learning about sustainability. There is also the necessity for more curriculum materials. Consequently, there is the potential for developing parallel curriculum contexts that link with the key competencies which, according to Chapman and Eames (2007), hold the most potential for the pedagogical realisation of EfS programmes.

8.9 Future research directions

This study has raised many questions for future investigation. Such questions have two directions, namely teachers' learning and children's learning.

In terms of teachers' learning, there is a need to find out how ontological change can be fostered so that teachers become advocates of teaching EfS programmes. Such change would need to be measured in order to assess the efficacy of professional development and a tool would need to be developed. Further investigation on professional development of teachers' understandings of sustainability is required and how to contextualise these understandings into classroom programmes would be necessary. In addition, Desimone's model (2007) is a generic one and there is a need for developing a model specificially designed to evaluate EfS professional development.

Similarly to teachers, children also need to undergo ontological change to develop pro-environmental values and behaviours. How such change could be fostered in children needs investigation. Ways of measuring ontological change in children also needs exploration. This research project has illustrated how young children can develop an understanding of the temporal component of sustainability and there is scope to find out if young children can develop understandings of the other components. Ways of assessing such understandings would also need development. Finally, these children were very young and it would be fruitful to explore the development of older children's understandings of sustainability, for example eight to ten year olds, or young adults of secondary school age.

8.10 Limitations of this research

Some limitations in this research project have been identified. The first limitation relates to the difficulty in identifying ontological change. The researcher was not able to look into the minds of the teacher participants and could only collect their responses to questions and their written statements. In addition, their responses were only what they chose to articulate and it might be that some teacher participants did not choose to offer all of their ideas at the time that data were gathered. On the other hand, the questions used might not have probed deeply enough in the time available.

Another limitation relates to the difficulty of exposing one's ontology to other people. A degree of trust is required when sharing one's personal mindset, values and beliefs. Consequently, only a small number of student teachers were willing to expose their beliefs by agreeing to take part in the research. This issue of trust also seemed to affect the way that only two practising teachers were willing to expose their ontologies and take a risk in their teaching by incorporating sustainability into their programmes. However, the small numbers of student and practising teachers did allow the researcher to collect rich, detailed descriptions of their understandings of sustainability and translations of understanding into their pedagogy.

In addition, the children in Hamish and Mike's classes were very young and they did not have a close relationship with the researcher which could have affected the interview data. Despite this limitation, sufficient data were generated in order to explore the effects of Hamish and Mike's translations of their understandings on these children's learning.

Finally, this research was conducted over a short period. Having the opportunity to explore the student teachers' incorporation of sustainability into their classroom programmes and practices would have strengthened these findings. In a similar way, investigating the way that Hamish and Mike incorporated sustainability into their future classroom programmes would add further to knowledge about the way that teachers translate personal understandings of sustainability into their classroom programmes.

8.11 Concluding statement

In conclusion, this project investigated teacher participants' understandings and awareness of sustainability and how their understandings could be developed. The findings showed that most of the teacher participants developed a deeper understanding of sustainability and that the activities that fostered critical reflection and discussion seemed to be the most effective in that development. This project also explored how practising teachers translated their understanding of sustainability into their pedagogy. These teachers seemed to translate their new understandings by developing simplified explanations or metaphors for sustainability appropriate for the age level of the children in their classes. Next they either developed the children's content knowledge and then related the simplified explanation to that knowledge or related it to prior learning. While many of the children were able to give a definition of sustainability similar to that taught, only two children were able to link the scientific concepts learnt with the concept of sustainability. Instead the learning about sustainability was diffused into their science learning where these children demonstrated understandings that were sophisticated for their young age. These findings illustrated the difficulties of teaching sustainability. Desimone's (2007) model was used to evaluate the professional development and served to highlight opportunities for future professional development. Finally, the effect of the teacher participants' understandings of sustainability on their identities as EfS teachers was explored. The findings showed that learning about sustainability affected many of these teacher participants' identities as EfS teachers. However, the findings also showed that identity formation is not only related to understanding, it

also encompasses a coherence of personal and professional beliefs, meaning that professional development in EfS needs to address more than just understandings in order to result in the pedagogical realisation of EfS.

This project has highlighted the significance of ontological change in teaching and learning about sustainability in order to bring about the required changes to behaviours and values that will lead to a halt to current environmental degradation and quality of life for all. However, such change is not limited to teachers and their classes of children, the education system itself needs to change ontologically so that there is a greater focus on developing pro-environmental values and behaviours (Hart, 2007). Effecting such a change could then result in people being on the 'right side' of Martin Luther King's radical revolution of values where people:

> *"… begin the shift from a "thing-oriented" society to a "person-oriented" society. When machines and computers, profit motives and property rights are considered more important than people, the giant triplets of racism, materialism and militarism are incapable of being conquered."*
>
> Martin Luther King Jr
> April 4, 1967

Appendices

Appendix A

Questionnaire

_____

Name/Male or Female

Sustainability Questionnaire

Age:_____

1. How would you rate your personal understanding of sustainability?

Very good	Good	Reasonable	Little	None
☐	☐	☐	☐	☐

In the box below, try to explain what is meant by 'sustainability'. Use the back of the page if you need more space.

2. Where have you learnt about 'sustainability'? (Tick box/es and give an example on line)

☐ Formal education, e.g. school, university _____

☐ Informal education, e.g. talks, courses run by local councils _____

☐ Media, e.g. TV, newspapers, magazines _____

☐ Books _____

☐ Discussions with family and peers _____

3. Name as many sustainability issues as you can (up to five):

1._____ 2._____

3._____ 4. _____

5. _____

Thank you for completing this questionnaire.
Sally

Appendix B

Permission to Use Questionnaire

Sally Birdsall Fri, 12 Oct 2007 12:15 PM

Subject: Re: An Inquiry
Date: Wednesday, 10 October 2007 9:44 PM
From: Mike Summers <mike.summers@edstud.ox.ac.uk>
To: Birdsall Sally s.birdsall@auckland.ac.nz
Conversation: An Inquiry

Sally
I have now retired and have not kept many records of my work. I attach a questionnaire which we used for the work youn mention. You have my permission to use this or anything else I have published.
Best wishes
Mike S.

In message
<9CC99A9EE44E434DB7EF38F92913F2DD1DBA79@foedmail01n.foed.auckland.ac.nz> "Birdsall Sally" <s.birdsall@auckland.ac.nz> writes:
> Dear Mike
>
> I have just finished reading your paper in Research in Science and Technological Education. I have also read some of your other articles about developing teachers' understanding of sustainable development and referred to them in my own writing.
>
> Like you, I am interested in people's understandings of sustainable development. I work in teacher education at the University of Auckland. I lecture in science and environmental education.
>
> In my master's thesis I investigated the development of 11-12 year old children's understandings of sustainable development through the course of an environmental education programme. I have just begun my doctorate where I aim to explore the development of primary pre-service teachers' understanding of sustainable development during the course of workshops that I intend to run and then look at how they utilise their understanding of SD in their classroom programmes.
>
> I was particularly interested in the questionnaire that you mention in the above article. I was wondering if you had published your instrument fully elsewhere? If not, would it be possible for you to send me a copy? Also, I would like to use that portion of your instrument that you used in your article in my doctorate. Would I be able to get your permission to do this?
>
> I look forward to hearing from you.
>
> Yours sincerely
> Sally Birdsall
> ##
> Attention:
> This e-mail message is privileged and confidential. If you are not the
> intended recipient please delete the message and notify the sender.
> Any views or opinions presented are solely those of the author.
>
> This e-mail has been scanned and cleared by MailMarshal
> www.marshalsoftware.com
> ##

--
Mike Summers
Department of Educational Studies
Oxford University, 15 Norham Gardens, Oxford OX2 6PY
Tel: 01865 274024

Appendix C

Picture Sorting Cards

Appendix D

PowerPoint Presentation about Sustainability

Defining Sustainability

2010

The Problem

- Degradation of our planet's biosphere
- Rapidly diminishing finite amount of resources
- Increasing numbers of people

A Possible Solution

- Need to achieve an environmentally sustainable society
- Needs to happen in an historically short period of time
- Education – strategy for change
- 'Re-orientation' of education
- Education for sustainability

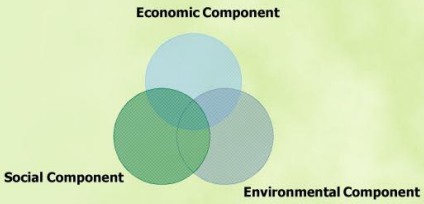
Origins of the Concept of Sustainability

- 1980 emerged as term 'sustainable development'
- Further currency in *Our Common Future* (1987)
- "Humanity has the ability to make development sustainable - to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs." (p. 8)

Defining Sustainability

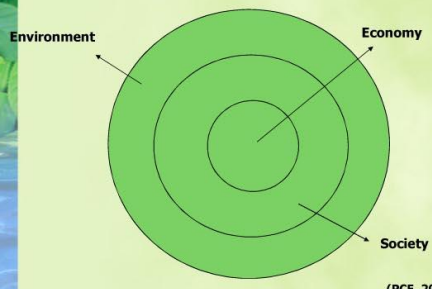
- Difficulty in defining concept
- Different interpretations based on an individual's values
- Interpreted along a continuum of people's values from the dominant social paradigm to the new environmental paradigm (Sterling, 1996)

Defining Sustainability



(PCE, 2002)

Defining Sustainability



(PCE, 2002)

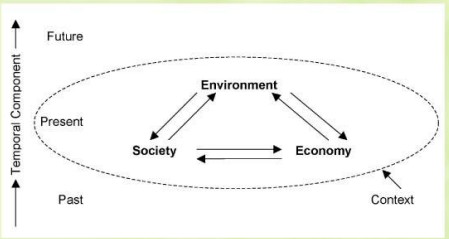
Potential Definition

- Acknowledge its value laden nature
- Has 3 components
- 3 components interrelated in a co-evolutionary way
- Open-ended with no boundaries (Gough, 2002)
- Bound to a context
- Temporal scale

Definition

- *Sustainability is made up of three interrelated components: environmental, social and economic. These components interact in ways that are unpredictable and co-evolutionary that effect further environmental change with unforeseen outcomes. Sustainability is a dynamic process but not the end point when working to resolve an environmental issue.*

Definition as a Model



Appendix E

Jigsaw Activity

Appendix F

Consequence Wheel Scenario

Your school has decided to implement a waste minimisation programme. It has been decided to:

- Start a worm farm
- Start paper recycling
- Start recycling of plastics, metals and glass

Look at the inner ring of the consequence wheel. Fill in 4 possible actions that you could take as a classroom teacher in this school in order to involve your class in the waste minimisation programme.

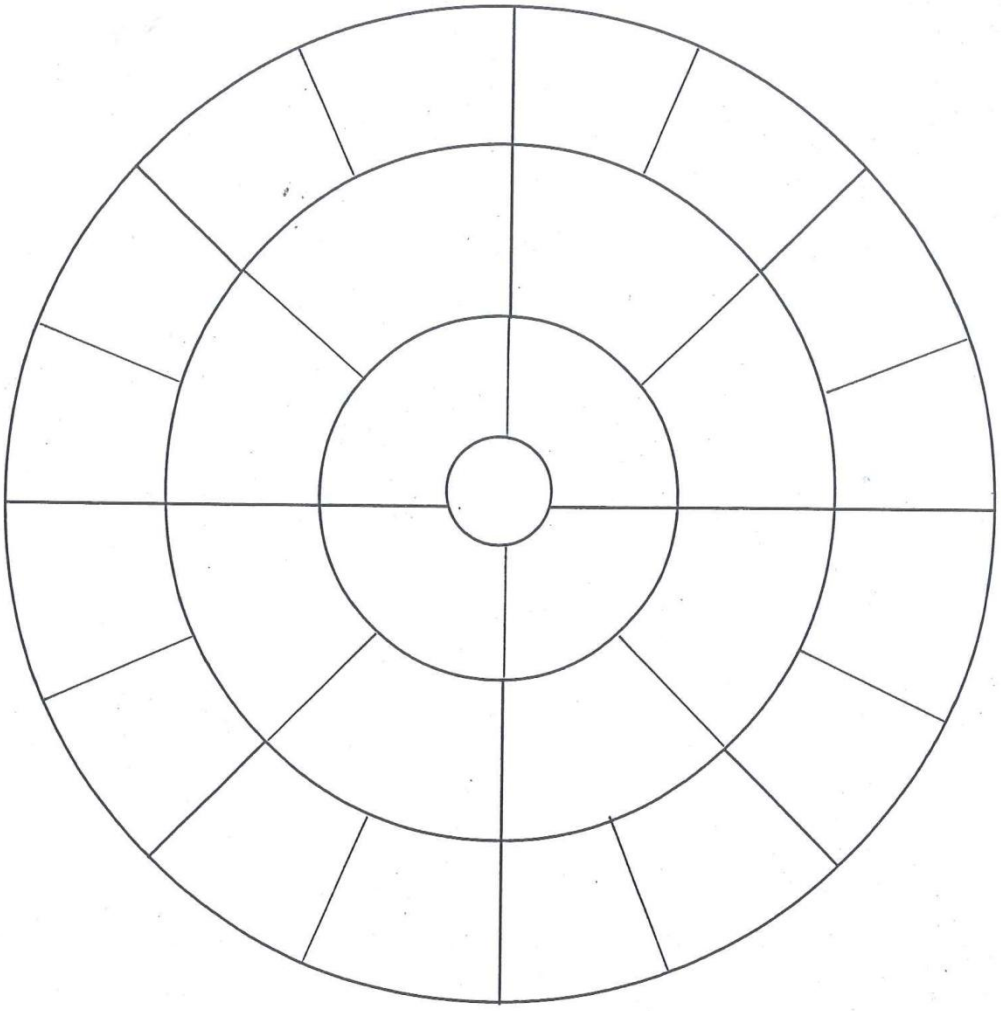
Look at the next ring. Fill in 2 possible consequences of those actions that could arise because of your class's involvement.

Look at the outer ring. Fill in 2 possible consequences of the consequence from the middle ring.

Think about your possible consequences. How do they relate to your understanding of sustainability?

Appendix G

Consequence Wheel Outline



Appendix H

Diamond Ranking Activity

Appendix J

Peer Interview Questions

The participants will interview each other about the workshops and their experiences.

Possible questions to ask:

- Why did you decide to take part in the workshops?
- Has your understanding of sustainability changed? How has it changed?
- How do you think your understanding of sustainability will impact on your teaching?
- What was the most important thing/concept that you think that you have learnt? Why do you think so?
- What activity(ies) do you think were the most valuable in shifting/changing your ideas? Why were they valuable?
- Which activity(ies) do you think will be useful in a classroom programme and why?
- Was there anything that you found particularly interesting during the workshops?

Appendix K

Indicative Questions to be used in the Individual Interview

For the Take Home Activity, can you please choose an article from a magazine, newspaper or book that shows an aspect of sustainability.

The Take Home Activity will look like this:

Take Home Activity

Place article chosen here

(Article can be from newspapers, books, magazines, etc.)

I selected this article because …

(Here the participants will record their reasons for their choice of article)

Indicative questions to be asked during individual interview:

- Can you please explain why you chose this article?
- How is the concept of sustainability expressed in this article?
- What effect, if any, did the workshop activities have on your choice?
- How do you think you could use this article in a classroom programme?
- Do you use any sustainable practices in your personal life?
- Have you incorporated any sustainable practices into your personal life as a result of participating in the workshops?

Appendix L

Indicative Questions used to Interview Hamish and Mike about their Teaching

Why did you choose to teach sustainability in this context (relevance)?

Tell me what you did this week in your teaching. Where are you in your planning?

What is going well/not so well?

How do you think the children's learning is progressing? Are there any concepts that they are finding easy/difficult?

Where do you plan to go from here? Why?

Have you taught about sustainability yet?

How did you introduce it?

How do you think their learning about sustainability is progressing? Have you seen any evidence of children 'getting it'?

Are there any activities that you think are particularly effective to use when teaching about sustainability?

How do you plan to make links between the children's learning and their lives outside the classroom?

What activities have you done that foster feelings of emotion about the environment?

How do you plan to finish off your EfS programme?

Appendix M

Questions for Final Interview about Identity

Being a Teacher
Describe yourself as a teacher.
Do you think you have a particular teaching style?
Can you describe it?
How did you arrive at this style?
Do you have a favourite type of activity you like to incorporate into your teaching programme?
Although primary teaching is generalist, do you feel a particular affinity towards any learning area?
How do you do to foster and grow this affinity?
Do you belong to any groups either inside or outside of school that have a sustainability focus? Tell me more.
Does this membership influence your teaching? Tell me how.
Can you talk about your household/personal life where you practise sustainability? If so, can you give examples?
Do these practices influence your teaching? Tell me how.

Teaching Expertise
Tell me how you think sustainability is mandated in the curriculum? In your school's policies and school wide programmes?
When you incorporated sustainability into your recent teaching, what changes did you have to make to your planning? To the way you teach? To the way you assessed the children's learning?

Professional Development
Tell me about any professional development that you have recently done.
How often do you get professional development?
How important do you think professional development is for a teacher?
Do you choose your professional development or is it decided for you?
What do you think is the ideal type of professional development for teaching about sustainability?

Discussions with Colleagues
Do you have a buddy that you discuss professional ideas with?
How valuable do you find such discussions?
Did you ever talk about your sustainability teaching with others? Who? What did you discuss?
Do you think about your teaching? Does this impact on your teaching? If so, how?
Did you think about your sustainability teaching? If so, what did you think about and what sort of decisions/ideas did you arrive at?

Thinking about Sustainability
What were your initial feelings when beginning this research project?
What do you think now?
How will it impact on your future teaching?
How have your personal beliefs about sustainability impacted on your teaching?
Teaching about sustainability has a political dimension – it involves exposing your personal values and beliefs. How do you think about this? Were you comfortable doing this? Do you think it is part of the teacher's role?

Appendix N

Indicative Questions for Interview with Children

Hamish's Class

I've got some cards here. Can you tell me what's on the cards? You know that there are 3 types of bees, can you tell me which one is which?

Can you tell me about what each bee does in the hive?

Do you think that bees are important? Why are they important?

Your teacher has talked about sustainability. Do you know what it means?

Can you give me an example of sustainability?

Mike's Class

I've got some cards here. Can you tell me what they're of?

Can you put them in order please?

Can you tell me what's happening in the cards?

What would happen if the plant didn't make any flowers? Bee didn't come to the flower?

What would happen if a bird came and ate all the caterpillars? Or an animal ate all the butterflies?

Your teacher has talked about sustainability. Do you know what it means?

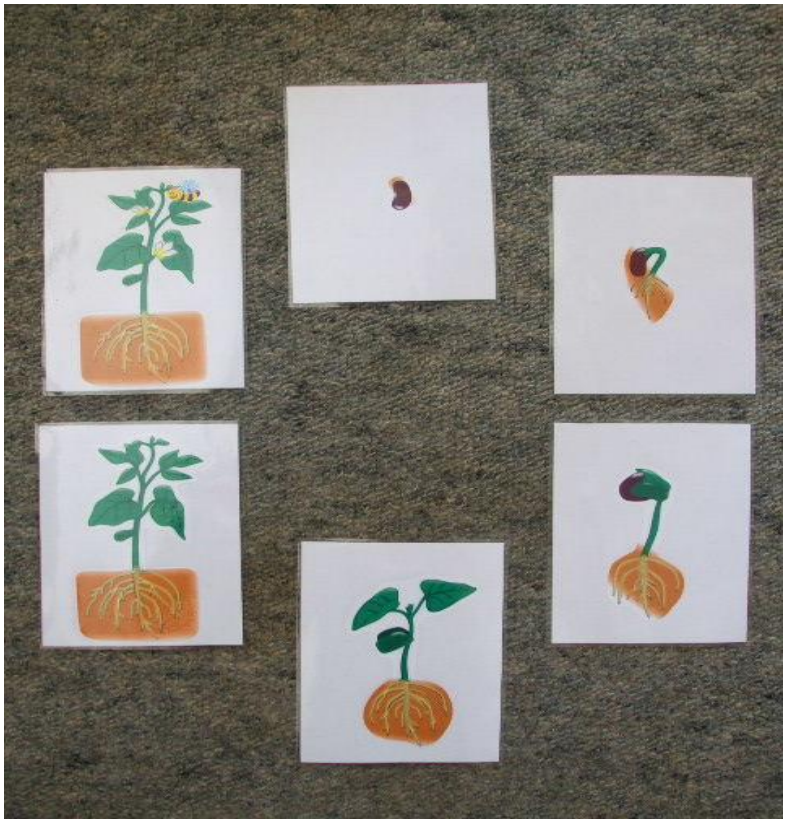
Can you give me an example of sustainability?

Appendix O

Pictures Used in Interviews with Hamish's Class of Children

Appendix P

Picture Cards used in Interviews with Mike's Class of Children



Centre for Science Education Science Unit/Lesson Planner

THE UNIVERSITY OF AUCKLAND
FACULTY OF EDUCATION
Te Kura Akoranga o Tamaki Makaurau
INCORPORATING THE AUCKLAND COLLEGE OF EDUCATION

Topic: Bees **Context: In the garden/orchard**
Year Level/s: Y3 L1/2 **Duration: 7 weeks Term 3, 2010**

BEE FRIENDLY

Science Concept(s)	Achievement Aims
• A bee is an insect and has three body parts, two pairs of wings and six legs. • Bees have a social structure; there are three different types of bees with different roles. • Bees have ways of communicating • The bee has a lifecycle; eggs, larvae, pupae to adult. • Some live in a hive which is carefully constructed • Bees collect nectar and pollen. They also make wax. The nectar is turned into honey. • People used lots of items made from bee by-products • Bees are very important to our survival as they help particular plants to reproduce. • The variety of food that we eat will be different if bees don't pollinate. • Bees protect themselves with a stinger. • Bees keep themselves warm by raising their temperature. • New Zealand native bees don't live in a hive and do not make honey • Many bees world –wide are dying and no one knows why • Bees live everywhere in the world except for Antarctica	Develop knowledge of the vocabulary, numeric and symbol systems, and conventions of science and use this knowledge to communicate about their own and others' ideas. Build their language and develop their understandings of the many ways the natural world can be represented.

Achievement Objectives – Contextual Strands (Knowledge/Understanding)		Build their language and develop their understandings of the many ways the natural world can be represented.	
Living World • Life processes – recognises that all living things have certain requirements • Ecology – recognise that living things are suited to their habitat • Evolution – recognise that there are lots of living things in the world that can be grouped in different ways.		• **Communicating in Science**- Build their language and develop their understanding of their many ways the natural world can be represented. **Vocab:** Abdomen, Pollen, Pollinate, Grub, Thorax, Antennae, honeycomb, pupa, hexagon, hive, worker, exoskeleton, larvae, wax, structure, extractor, drone, nectar, native, cells, apiary, queen Bee line Busy as a bee	
Key Competencies **Thinking** • Use their personal observations and experiences to make connections to new ideas • Ask questions and actively seek answers (wonder wall) • Compare and contrast bees and other animals and begin to classify **Thinking Skills** • **Describing** • **Sequencing** • **Compare and contrast** • **Classifying** • **Evaluate**	**Values** Innovation, inquiry and curiosity	**ICT** Kidspiration Video	**Resources/Reminders** Dairy of a Honeybee The Beekeeper

Learning Intentions or Intended Learning Outcomes (What should the students achieve?)	Learning Experiences (What are the students to do?)	Assessment Tasks (How can their achievement be measured and recorded?)
Identify the body parts of a bee	Construct a bee ag.arizona.edu/pubs/insects/ahb/act1 Activity sheet 1 In groups make a part whole chart using the body parts of a bee and their function. Compare and contrast bees and people	Children begin to use the correct terminology to describe body parts of a bee Activity sheet 2
Identify and describe the life cycle of a bee	In groups discuss and sequence the life style photos. Use the correct terminology to describe these changes. Video 'The Life Cycle of Wasps and Bees'	Children can sequence pictures of the life cycle of a bee and explain why they put the pictures in the way they did.
Classify bees and discuss the characteristics it has in common with other insects.	Sort a set of photos of bugs into groups and discuss why they put together certain insects. Make a classification chart.	
Describe the different roles bees have in a hive	arizona.edu/pubs/insects/ahb/act1 Activity sheet 2 DVD Social Insects	
Understand how bees and flowering plants depend on each other	DVD All about Bugs Walk around the school observing bees in action	Children can discuss, What if there were no bees.
Understand how bees help us	Share the book Honey Biscuits and make the biscuits.	Write a factual report about bees. Complete the before/ after information sheet
Evaluate the importance of bees and discuss ways we can protect them, sustainability	Research the types of plants bees like. Design a garden that will attract bees (The bank at the back of Room 1)	

Appendix R

Mike's Planning for Learning about the Garden's Ecosystem

Curriculum Area: Science **Strand/s:** Living world **Level:** 1/2 **Duration:** Term 1 week 5 – week 5 Term 2

Topic: New Beginnings – Life Cycles

Big Idea 1: All animals, plants and insects have a life cycle.

Big Idea 2: Some life history adaptations include changes in various forms, stages, castes that are specialised to carry out specific tasks.

NOS Level 1/2:

Understanding about science: *Students will...*
Ask open and closed questions to help investigate life cycles.
Investigating in science: *students will...*
Extend their experiences and personal explanations of life cycles through exploration, play, asking questions, and discussing simple models.
Communicating in science: *students will...*
Build their language associated with life cycles, and develop their understandings of the many ways the natural world can be represented.

Key Competencies:
Thinking ; Managing self ; Relating to others ; Participating and contributing; Using language, symbols, and texts

Assessment:
Draw and label/ sequence the stages of a monarch butterfly life cycle.
Explain/draw/represent the changes that occur in a life cycle studied.

Resources:
National/School library
BSC bk 4 section 1-3
BSC bk 25

Discussion Ideas:

- Establish prior knowledge of life cycles and monarch butterflies. Record these and use to compare before & after view.
- Read *'Butterfly Day'* (Ready to Read) or *'Caterpillars'* (pt2 no 1 2007). Develop scientific vocabulary. (Integrate with reading programme as shared reading to develop comprehension strategies; identify main ideas; inference; develop sequencing skills; compound words; descriptive vocab.
  Visual Language: Discuss design features-font size, headings, graphics etc.)
- Brainstorm questions & make wall charts with these displayed for students to complete during investigation.
- Use library books, internet, etc. to explore life cycles.
- **compare & contrast:** Compare monarch butterfly life cycle to other life cycles – (chicken, frog, plants, snail) and then draw both.
- Bring swan plant into classroom for children to observe changes of butterfly; plant seeds & observe growth. Measure & record

Learning Intentions: *Students can...*
Investigate and describe changes that occur within a butterfly's life cycle and other minibeasts. (A)
Observe and identify the parts of the butterfly / bee / frog life cycle (teachers to choose life cycle) (A)

Maori Terms:	**Evaluation of Unit:**
Kakahu - Monarch Butterfly Seed - K kano Frog – Pekepeke Flower - Pua Bud - Ao	

Curriculum Area: Science **Strand:** Living world ~ Life Processes **Level:** 1/2 **Duration:** Term 1 week 5 ~ week 5 Term 2	
Topic: What's in our garden?	
Big Idea 1: Plants grow from seeds. **Big Idea 2:** Many plants have flowers that produce seeds before they die. **Big Idea 3:** Plants benefit people and our environment.	**Achievement Objective:** *Students will...* Recognise that all living things have certain requirements so they can stay alive.
NOS Level 1/2: Understanding about science: *Students will...* Ask questions about plants that lead to investigations, and understand that all living things have certain requirements so they can stay alive. Investigating in science: *students will...* Extend their experiences and personal explanations of plants through exploration, asking questions, and discussing findings. Communicating in science: *students will...* Build their language about plants and share this through a variety of ways. Develop an understanding of how plants can benefit us and our environment. Participating and contributing: *students will...* Explore and act on issues such that affect their lives and questions that link their science learning to their daily living.	**Learning Intentions:** *Students can...* Identify parts of a plant. (A) Explain where they come from and how they grow. (A) Identify what plants needs for growth. Recognise how plants are a benefit to people & our environment. **Key Competencies:** Thinking ; Managing self ; Relating to others ; Participating and contributing; Using language, symbols, and texts **Assessment:** Sequence the stages of a plant's life (4 pictures). Label the different parts of a flowering plant (roots, stem, leaf, flower). Describe the functions of 2 different parts of a plant (as above). Use any of the activities to assess student progression and understanding of concepts. Some specific assessment activities have been identified. Use matrix D to assess student understanding.(copy enclosed with plan)
Introduction: Brainstorm ideas from questions listed & display (FA) • *What do we need to survive?* • *What do plants need to survive?* • *Where do they come from & how do they grow?* **What is a seed?** Looking inside & outside of a seed (Soak lima bean in water overnight) Use magnifying glasses to examine outside of bean. *What can you see?* Discuss what the seed coat is for. Show a peanut inside lunch box to explain concept of protection. **(be aware of allergy children)** *What do both of these have things have in common?* Peel of covering & split in half to look at parts.	Writing activity: I found a seed and it grew into ---------- **Root system:** Investigate what this is, & why it is important. Place a carnation/celery stick in coloured water. Children predict what might happen. Use drama to depict plant growth. Using digital camera photograph changes & children write captions to explain what has happened. **Animals & plants are partners:** *What would it be like without plants?* Discuss benefits of plants in our environment & some issues that arise. How can we help? Discuss ways in which plants contribute to Earth.

Seeds come in all shapes & sizes: Display variety of seeds(carrots, lettuce, watermelon, marigold, sunflower, potatoes, onions) for children to explore & see the above. Estimate which ones would fill a small cup quicker. Graph results. Some seeds grow from other plants (tubers). Create a seed collage. **How do seeds travel?** Wind, animals, etc. Brainstorm ideas. Children wear old socks to walk around school & examine what they have picked up. Read selected picture book(see reference list) Writing activity: **"Splash"** Using your imagination, pretend you are a coconut that has just fallen off a palm tree into the ocean. What happens to you? **What do seeds need to grow?** Sprout seed in jar/clear plastic cup with wet paper towels (bean, alfalfa work well) & store one in dark place (A) & the other in a light place (B). *Which seed will grow best?* Estimate how long it will take for seeds to germinate(record & display) Use digital camera to show progression of growth. When germinated, measure growth weekly & graph results. Plant in soil when too big. *Why did seed A grow better than seed B?* **(SA)**	
Maori Terms: see glossary back of book 51	**Resources:** BSC book51 NZC

SCHOOL OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

THE UNIVERSITY OF AUCKLAND
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Te Kura Akoranga o Tāmaki Makaurau
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Auckland, New Zealand
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Facsimile 64 9 623 8892
www.education.auckland.ac.nz

The University of Auckland
Private Bag 92601, Symonds Street
Auckland 1035, New Zealand

Appendix S

Request for Site Access from Dean of Faculty

Dean of the Faculty of Education – Information Sheet

Title: From personal understanding to practice: How teachers contextualise their understanding of sustainability
Researcher: Sally Birdsall

To: Dr John Langley

My name is Sally Birdsall. I am currently enrolled in a Doctor of Philosophy at The University of Auckland and am a lecturer in the School of Science, Mathematics and Technology Education. As part of my work, I also lecture in an environmental education course. I am researching primary pre-service teachers' understanding of the concept of sustainability. I would like to carry out this research project with the cohort of students in their third year of their B.Ed. (Tchg) degree at the Epsom Campus.

I am interested in finding out these pre-service teachers' understanding of sustainability. The research will attempt to answer the following questions:

- What do primary pre-service teachers think that the concept of sustainability means?
- What changes occur to the pre-service teachers' understandings of sustainability following their participation in a series of workshops about sustainability?

I would like your permission to approach the entire cohort of the third year primary pre-service teachers at the end of one of their lectures in the EDUC 320 course. At this time, on my behalf, Dr Bev France will inform the pre-service teachers about the research and invite them to complete a questionnaire at the end of the lecture the following week. Those pre-service teachers who wish to participate further in this project by attending three workshops will be invited to register their interest and give their contact details to Ms Delwyn Wyatt, the Science Technician in the School of Science, Mathematics and Technology Education. These three workshops are not part of any course being run at the Faculty.

The maximum number of participants in the workshops will be 16. If more than 16 pre-service teachers indicate their interest in taking part, then the names of the 16 participants will be randomly selected.

I am also seeking your permission to hold the three workshops at the Epsom campus. The workshops will be held on consecutive Tuesday afternoons after lectures have concluded and will last between 1 to 1 ½ hours each. I would also like your permission to use a classroom to hold one individual interview with those pre-service teachers who participate in the workshops.

During the workshops these pre-service teachers will take part in activities designed to deepen their understanding about sustainability. Their responses will be audio-taped and their completed activities either photographed or
collected. At the conclusion of the workshops, the teachers will be given a pack that contains resources for all of the activities used in the workshops.

The potential participants will be assured both verbally by Dr France and in writing that their decision to participate or not in this research project will not affect their grades or standing within the teacher education programme.

All of the tapes, transcripts, photographs and copies of completed activities will be stored securely and kept for six years before being destroyed by a secure disposal agency.

A summary of the research findings will be available. If you wish to receive a copy, please indicate on the consent form.

If you have any questions about this research, please contact my supervisors or myself. The contact details are:
Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Extn 48468
Dr Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Extn 48439
Dr Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Exn 48964

If you have any concerns of an ethical nature you can contact the Chair of The University of Auckland Human Participants Ethics Committee on 09 373 75999 Xtn 87830.

Yours sincerely

Sally Birdsall

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 18 February 2008 for 3 years from 18/02/08 to 18/02/11.
Reference number: 2007/422

SCHOOL OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

THE UNIVERSITY OF AUCKLAND
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Appendix T

Participant Information Sheet about Questionnaire

Information Sheet to Accompany Questionnaire

Title: From personal understanding to practice: How teachers contextualise their understanding of sustainability
Researcher: Sally Birdsall

To: Pre-service Teachers Completing the Questionnaire

My name is Sally Birdsall. I am currently enrolled in a Doctor of Philosophy at The University of Auckland and am also a lecturer in the School of Science, Mathematics and Technology Education. I would like to carry out some research about your understanding of sustainability.

This research will be attempting to answer the following questions:

- What is your understanding of the concept of sustainability?
- What changes occur to your understanding of sustainability following your participation in a series of workshops about sustainability?

The first part of my research project involves you completing an anonymous questionnaire which will take around 5 – 10 minutes to complete. Your completion of the questionnaire will be regarded as giving your consent to take part. You will be given a lollipop to thank you for completing the questionnaire.

The second part of the research project is a series of three workshops. During these workshops you will take part in activities that are designed to deepen your understanding of sustainability. These activities will include picture sorting, a jigsaw, a diamond ranking activity, and taking part in a goldfish debate. At the final workshop, you will be given a copy of every activity completed so that you could use these activities in your own classroom. The workshops will be held on Tuesday afternoons after 2.15pm and will last no longer than 1 ½ hours.

If you are interested in taking part in these workshops, please give your contact details to Mrs Delwyn Wyatt by 31 March 2008. Her contact details are:
Phone: 623 8899 Xtn 48387
Email: d.wyatt@auckland.ac.nz
Room: A336 (third floor of A Block)

I will then get in touch with you to remind you about the start date. Should more than 16 people register their interest, the names of those people who will attend the workshop will be randomly selected and you will be advised of the outcome.

You will see that I have asked you to code your questionnaire using the initial of your first name, the day and month of your birthday and indicating whether

the workshops, your questionnaire can be identified by you. I would then ask you to leave your code with Mrs Delwyn Wyatt so that she can locate your questionnaire. The data on the questionnaire will then be compared with data gathered using another questionnaire at the end of the workshops. This does mean that your questionnaire is no longer anonymous. However, your identity will be protected by me in my thesis and in any subsequent publications through the use of a pseudonym.

If you do not wish to take part in the workshops, your questionnaire will remain completely anonymous. These questionnaires will be stored securely and kept for six years before being destroyed by a secure disposal agency.

Your decision to participate in this research project will in no way affect your grade or your standing within the teacher education programme.

If you have any questions about this research, please contact my supervisors or myself. The contact details are:
Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Extn 48468
Dr Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Extn 48439
Dr Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Exn 48964

If you have any concerns of an ethical nature you can contact the Chair of The University of Auckland Human Participants Ethics Committee on 09 373 75999 Xtn 87830.

Yours sincerely

Sally Birdsall

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 18 February 2008 for 3 years from 18/02/08 to 18/02/11.
Reference number: 2007/422

SCHOOL OF SCIENCE, MATHEMATICS AND TECHNOLOGY EDUCATION

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Appendix U

Student Teacher Participant Information Sheet about Workshops

Participant Information Sheet - Workshops

Title: From personal understanding to practice: How teachers contextualise their understanding of sustainability
Researcher: Sally Birdsall

To:

My name is Sally Birdsall and I am currently enrolled in a Doctor of Philosophy at The University of Auckland. I would like to carry out some research with you during March and April. In this project I will be investigating your understanding of the concept of sustainability.

This research will be attempting to answer the following questions:

- What is your understanding of the concept of sustainability?
- What changes occur to your understanding of sustainability after your participation in a series of workshops about sustainability?

Thank you for registering your interest in this project. Your name has been selected and I invite you to take part in my research. If you agree to participate, data will be collected in the following ways. You have already completed the initial questionnaire. Next stage is a series of three workshops where data will be collected. Peer interviews will take place during the workshops. I would also like to interview you individually about one activity for 10 – 15 minutes at a time negotiated with you. At the conclusion of the workshops, you will receive a package that contains copies of all of the activities used in the workshops for use in your future classroom programmes.

As this research will involve group work, you will need to make a commitment of around 4 - 5 hours to attend the three workshops. It is intended that the workshops will be held on Tuesdays from 2.30 to 3.30pm in A322 at the Epsom Campus on 6, 13 and 30 May.

During the workshops your ideas and opinions will be audio-taped and the transcriptions of these tapes returned to you for verification. Any issues that arise from these recordings will discussed at the workshops. Any discussions arising from this process will be minuted. In addition, where appropriate, photos will be taken of completed activities only or a copy of the completed activity retained. No photos will be taken of you participating in any activity in the workshops. I would also like your permission to use these photographs in my thesis and in any publications.

I also request permission to audio-tape an individual interview with you in between the second and third workshop. This interview will also be transcribed and returned for you to verify and edit.

All of the tapes (pair, group and individual), transcripts, photos and copies of the completed activities will be stored securely and kept for six years before being destroyed by a secure disposal agency.
You will have the opportunity to choose a pseudonym so that your identity will be protected in my thesis and subsequent publications. Because of the pair and group interaction during the workshops, confidentiality cannot be guaranteed. However, all the participants will be asked to agree to professional confidentiality about the pair and group interactions. In addition, you may feel that it will be easy for your ideas and contributions to be identified by others in my thesis. I will ensure that I keep personal details to be minimum to reduce the chance of recognition occurring.

During the individual interview, you will have the right to request that the audio-tape be turned off at any time. You also have the right to withdraw from this research up to 15 June 2008. If you do decide to withdraw, the data from your individual interview will be returned to you but not your contributions to the group activities.

If you should experience a sense of discomfort about any of the topics discussed or political values expressed, you can contact my supervisors to talk about any issues. My supervisors' contact details are given below.

The research project described above is the first part of the project. In the second part, I would like to interview practising teachers who are teaching an environmental education programme about the way that they have incorporated sustainability into their programme. I would like your permission to approach you to invite you to participate in the second part of this research which will be carried out following the workshops.

A summary of the research findings will be available for you. If you wish to receive a copy, please indicate on the consent form.

If you have any questions about this research, please contact my supervisors, the Head of Science, Mathematics and Technology Education or myself. The contact details are:
Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458.
Dr Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439.
Dr Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964.
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 623 8899 Xtn 48517.

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Phone (09) 373-7599 Xtn 83711.

Yours sincerely

Sally Birdsall

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 18 February 2008 for 3 years from 18/02/08 to 18/02/11.
Reference number: 2007/422

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Appendix V

Teacher Participant Information Sheet - Workshops

Title: From personal understanding to practice: How teachers transform their understanding of sustainability
Researcher: Sally Birdsall

Dear

My name is Sally Birdsall and I am currently enrolled in a Doctor of Philosophy at The University of Auckland. I would like to carry out some research with you during January 2010. In this project I will be investigating your understanding of the concept of sustainability.

This research will be attempting to answer the following questions:

- What is your understanding of the concept of sustainability?
- What changes occur to your understanding of sustainability after your participation in a series of workshops about sustainability?

I invite you to take part in my research. If you agree to participate, data will be collected in the following ways. Firstly you will complete an initial questionnaire. Next stage is a series of three workshops where data will be collected. Peer interviews will take place during the workshops. I would also like to interview you individually about one activity for 10 – 15 minutes at a time negotiated with you. At the conclusion of the workshops, you will receive a package that contains copies of all of the activities used in the workshops for use in your future classroom programmes.

As this research will involve group work, you will need to make a commitment of around 4 - 5 hours to attend the three workshops. It is intended that the workshops will be held at your school, xxx Primary, during the last week of January 2010.

During the workshops your ideas and opinions will be audio-taped and the tapes transcribed by a university approved transcriber who will sign a confidentiality agreement. The transcriptions of these tapes returned to you for verification. Any issues that arise from these recordings will discussed at the workshops. Any discussions arising from this process will be minuted. In addition, where appropriate, photos will be taken of completed activities only or a copy of the completed activity retained. No photos will be taken of you participating in any activity in the workshops. I would also like your permission to use these photographs in my thesis and in any publications.

I also request permission to audio-tape an individual interview with you in between the second and third workshop. This interview will also be transcribed and returned for you to verify and edit.

All of the tapes (pair, group and individual), transcripts, photos and copies of the completed activities will be stored securely and kept for six years before being destroyed by a secure disposal agency.

You will have the opportunity to choose a pseudonym so that your identity will be protected in my thesis and subsequent publications. Because of the pair and group interaction during the workshops, confidentiality cannot be guaranteed. However, all the participants will be asked to agree to professional confidentiality about the pair and group interactions. In addition, you may feel that it will be easy for your ideas and contributions to be identified by others in my thesis. I will ensure that I keep personal details to be minimum to reduce the chance of recognition occurring.

During the individual interview, you will have the right to request that the audio-tape be turned off at any time. You also have the right to withdraw from this research up to one week after the workshops have been held. If you do decide to withdraw, the data from your individual interview will be returned to you but not your contributions to the group activities.

Your Principal has given an assurance that your decision to take part in these workshops or not will have no effect on your employment status at xxx Primary School.

If you should experience a sense of discomfort about any of the topics discussed or political values expressed, you can contact my supervisors to talk about any issues. My supervisors' contact details are given below.

The research project described above is the first part of the project. In the second part, I would like to interview practicing teachers who are teaching an environmental education programme about the way that they have incorporated sustainability into their programme. I would like your permission to approach you to invite you to participate in the second part of this research which will be carried out following the workshops.

A summary of the research findings will be sent to your Principal in 2012 for you to view.

If you have any questions about this research, please contact my supervisors, the Head of Science, Mathematics and Technology Education or myself. The contact details are:
Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458.
Dr Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439.
Dr Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964.
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 623 8899 Xtn 48517.

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Phone (09) 373-7599 Xtn 83711.

Yours sincerely

Sally Birdsall

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE ON 18 February 2008 for 3 years from 18/02/08 to 18/02/11.
Reference number: 2007/422

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Appendix W

Request for Site Access for EfS Programme Teaching

PARTICIPANT INFORMATION SHEET
REQUEST TO ACCESS THE SCHOOL
(Principal/Board of Trustees)

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER:*Sally Birdsall*

Dear

My name is Sally Birdsall and I am currently enrolled in a Doctorate at the University of Auckland. My research is focussed on finding out how teachers' developing understandings of sustainability can be transformed into their classroom programmes. You are aware that I am running a series of workshops that have been planned for January 2010 and a group of teachers from your school have agreed to take part. I want to find out how they transform their understandings into their classroom programmes and how their classes express their understandings of sustainability.

I request access to your school, and in particular, to the teachers that have identified their willingness to take part in the workshops. I want to be able to collect data on these teachers' education for sustainability programmes and student outcomes. If you allow this access I request permission to approach these teachers and would like your assurance that if they decide to take part/or not in this research, there will be no effect on their employment status.

If you agree, this research will involve teachers supplying classroom planning documents, resource materials and being interviewed both individually and as a focus group about their EfS programme. In addition I would like access to: children's work (assessment tasks, presentations that are videoed), as well as a small number of children who will explain their group presentations and/or their sustainability posters. I would like to carry out this research with the classes taught by these teachers (Years 1-6) during February to June 2010. The timing of these programmes will be left to the teacher in charge of EfS (Brian Coleman) to arrange.

Because your children are under 16 years I will be asking permission from their parents, however I consider it important that the children are consulted and PIS and CFs will be provided for them too. I enclose copies of all information given to teachers, children and parents for your information.

As you are aware, reflection on professional development will improve your teachers' pedagogy. I will provide you with a copy of the findings from this research in 2012 to distribute to the participant teachers. It is up to you to decide whether to distribute the findings to parents/guardians as you see fit.

I hope you will give permission for this research to take place in your school. If you have any queries please contact my supervisors, the Head of Science, Mathematics and Technology Education or myself. Our contact details are:

Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458
Associate Professor Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439
Associate Professor Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 623 8899 Xtn 48517

Yours sincerely

Sally Birdsall
s.birdsall@auckland.ac.nz

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Tel (09) 373-7599 ext 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICPIANTS ETHICS COMMITTEE on 12 February 2010 for a period of three years, till 10 February 2013 Reference 2009/518

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Appendix X

Teacher Participant Information about Teaching EfS Programme

PARTICIPANT INFORMATION SHEET (Teacher)

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER: *Sally Birdsall*

Dear

My name is Sally Birdsall and I am currently enrolled in a Doctorate at the University of Auckland. My research is focussed on finding out how teachers' developing understandings of sustainability can be transformed into their classroom programmes. As you know I am conducting workshops at your school to explore and develop your understandings of sustainability. The next part of my research is to see how you translate these understandings of sustainability into your classroom programme and explore the learning that occurs with your children. I invite you and your class to take part in this next stage that will occur between February and November 2010 at a time that suits you and your syndicate.

Your role in this research would be to teach the programme that has been designed by the school's EfS team. In order to answer the following research questions:

- How do teachers transform their understandings of sustainability into their classroom programmes?
- How do children express their understandings of sustainability when presenting possible solutions to an environmental issue?

I would need to collect from you and your class: the unit plan, classroom resources, assessment tasks and assessed children's work. As this will be part of your normal programme, I would like to be able to photocopy this material after appropriate coding has occurred to protect everybody's anonymity. In order to monitor the development of your ideas, I would like to interview you both individually (30 minutes) and with your colleagues in a focus group interview (1 hour) using audio-tape. To answer the second research question, I would like to video your class presenting their group sustainability outcomes, and the opportunity to carry out a tape recorded interview with the leader of each group (10 minutes) about their decisions and understandings. Also an additional assessment task which involves captioning a poster, will be given to all of the children to complete and I would like the opportunity to interview selected children about their posters (10 minutes).

I anticipate that both you and your children will have a range of views about sustainability and these could be recognised by your colleagues and other children. To ensure your anonymity you will be given a pseudonym and identifiable details about you, your class and the school will be disguised. Because many of these ideas will be discussed in class and in the teacher focus group, confidentiality cannot be guaranteed. These issues will be identified and explained for you, your children and their parents in the appropriate PIS and CFs. Interview data will be coded and a transcriber will be asked to sign a confidentiality agreement. This research will involve the collection of a large amount of information and this will be coded and stored in a safe place for six years at the University separate to any identifiers. After this time, the information will be destroyed.

Both you and your class can withdraw from this research up to one week after the commencement of the research period and the Principal has assured me that your decision

will not affect your employment in any way. When individual interviews are audio-taped you can request to turn the recorder be turned off at any time. However in the focus group interview you can withdraw at any time but your contribution will remain up to your withdrawal.

If you agree to take part, I would like to talk to your children about this research and distribute information sheets to your children for them and their parents. I enclose copies of these PIS and CFs for your information.

I hope that this research will give you the chance to develop your ideas about sustainability and teaching. The results of this research will be available by 2012 and I will be sending your Principal a copy of the findings to pass onto you.

If you have any queries please contact my supervisors, the Head of the School of Science, Mathematics and Technology Education or myself. The contact details are:

Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458
Associate Professor Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439
Associate Professor Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 48517

Yours sincerely

Sally Birdsall

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Tel (09) 373-7599 ext 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICPIANTS ETHICS COMMITTEE on 10 February 2010 for three years. Reference Number 2009/518

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Appendix Y

Parent Participant Information Sheet

PARENT INFORMATION SHEET

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER:*Sally Birdsall*

Dear Parent,

My name is Sally Birdsall and I am currently studying for a Doctorate at the University of Auckland. As you know, knowledge about environmental issues is of importance to children's education and understanding issues about sustainability can provide children with the tools for making informed decisions. I want to find out how teachers translate their understandings of sustainability into their classroom programmes and what children learn from this experience.

As your child is under sixteen years of age, it is necessary to obtain your permission for your child to take part in this research. However, I believe it is important for children to be involved and I will ask permission of them as well. I enclose a copy of the information given to your child for your information.

If you agree and your child does not, their data will not be used. The information that I would be using will be your child's assessed work that will be made anonymous and stored securely at the University for a period of six years. After this date it will be destroyed. It is hoped that the leaders of groups of children will present their plan for a sustainable solution to an environmental issue and this will be video-taped. If your child is selected to be a leader and present, your child's identity will be protected by pixelating their face and their comments will be coded before transcribing. As before, this data will be kept securely and destroyed appropriately. Because children are presenting their material in class, I cannot guarantee that this information will be kept confidential, however, a discussion will occur about keeping this information confidential within the class.

The research will be part of a teaching programme that will occur between August and November 2010 and your child's teacher will inform you of the exact date. If you decide you do not want your child involved, they will continue with the teaching programme but none of their work will be considered and this will have no effect on their marks or grades. You can withdraw your child's participation up to two weeks after the start of the programme.

Your child could be selected to be video-taped individually while presenting their group's sustainability solution (10 minutes). This activity will be part of the normal classroom programme and involve your child working in a group. Part of the task will involve each group choosing a leader to present that group's ideas and if your child is chosen by their group to be that leader, their presentation will be video-taped.

Also, your child could be selected to be interviewed about their sustainability poster if it shows interesting and considered ideas (10 minutes). Completing this poster will be part of the normal classroom programme. These interviews will be audio-taped in a private room at the school and your child can stop the interview and turn the audio- tape recorder off at any time. This information will be transcribed and kept securely.

I hope you will allow your child to be involved as it will give them an opportunity to talk to an adult about their understandings and this information will make a significant contribution to educational research about sustainability.
The results of this research will be made public in 2012 and the school and teachers concerned will be provided with copies of this publication.

If you have any queries please contact my supervisors, the Head of the School of Science, Mathematics and Technology Education or myself. Our contact details are:

Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458
Associate Professor Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439
Associate Professor Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 623 8899 Xtn 48517

Yours sincerely

Sally Birdsall

For any enquiries regarding ethical concerns please contact: The Chair, University of Auckland Human Participants Ethics Committee, The University of Auckland, Research Office – Office of the Vice Chancellor, Private Bag 92019, Auckland. Tel (09) 272 7999 ext 87830.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICIPANTS ETHICS COMMITTEE on 10 February 2010 for a period of three years. Reference 2009/518

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Appendix Z

Consent Form for Parents

CONSENT FORM
(Parents)
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER: *Sally Birdsall*

I have read the Participant Information Sheet and have understood the reasons for this research and why my child has been asked to take part. I have had the opportunity to ask questions and have them answered to my satisfaction.

- I agree for my child to take part in the research.

- I understand my child is free to withdraw from this research up to two weeks after the commencement of the teaching programme and will continue to be part of the programme but their classroom work will not be used in this research project.

- I understand that my child's anonymity will be protected.

- I understand that a third party who has signed a confidentiality agreement will transcribe the recorded material.

- I understand that the data will be stored securely and disposed of after six years.

- If my child is selected, I agree/do not agree for my child to be audio-taped when talking about their poster.

- I understand that my child can turn off the audio-tape at any time during the interview.

- If my child is selected, I agree/do not agree for my child to be video-taped when talking about their group's ideas about a solution to the problem.

Thank you for agreeing for your child to take part in this research.

Name:……..

Signed:……Dated:……

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICPIANTS ETHICS COMMITTEE on 10 February 2010 for three years. Reference Number 2009/518

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Appendix AA

Children's Participant Information Sheet

STUDENT INFORMATION SHEET

(Please read this information aloud to your child)

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER:*Sally Birdsall*

Dear Student

My name is Sally Birdsall and I am studying at the University of Auckland. I hope to become an education doctor and need to find out about your learning. I am very interested in how children learn about sustainability. As you know, it is very important to look after our environment and we need to make sure that we take care of it. Your teacher will be teaching you about how to take care of the environment and I would like to find out your ideas and see your school work for my research. Your teacher will tell you when you will do this at school sometime this year.

You and your parents will need to talk about this and decide if you want to take part. If your parents say yes, you need to write your name on the special form. If you decide that you don't want to take part, that is okay and you will take part in the lessons just like everybody else but your work will not be used. If you want to take part, I may need to interview you by yourself and I will be asking you questions about your ideas. Your ideas are very important and I need to record them on an audio-tape recorder that you can turn off if you decide you don't want to do it anymore. Your important ideas will be kept safely at the university. During one lesson your teacher will be recording you on video and after I have written down your ideas, I will make sure I will change the tape so other people can't see your face. Like the rest of your ideas, it will be kept safely.

If you change your mind, that's okay. It would be hard for me if you do change your mind too late in the teaching, so you have two weeks once the teaching has started to make up your mind for good.

This research is really important to me and I think that you will learn a lot and enjoy talking about your ideas with your friends.

If you have any questions, please ask your teacher and they will send your questions on to me or to my teachers. These addresses are written below:

Sally Birdsall: email s.birdsall@auckland.ac.nz or phone 09 623 8899 Xtn 48458
Associate Professor Bev France: email b.france@auckland.ac.nz or phone 09 623 8899 Xtn 48439
Associate Professor Mavis Haigh: email m.haigh@auckland.ac.nz or phone 09 623 8899 Xtn 48964
Dr Gregor Lomas: email g.lomas@auckland.ac.nz or phone 09 623 8899 Xtn 48517

Yours sincerely

Sally Birdsall

For any queries regarding ethical concerns you may contact the Chair, The University of Auckland Human Participants Ethics Committee, The University of Auckland, Office of the Vice Chancellor, Private Bag 92019, Auckland 1142. Tel (09) 373-7599 ext 83711.

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICPIANTS ETHICS COMMITTEE on 12 February 2010 for three years. Reference Number 2009/518

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Appendix AB

Consent Form for Children

CONSENT FORM
Please read this information aloud to your child
(Child)
THIS FORM WILL BE HELD FOR A PERIOD OF 6 YEARS

TITLE: From personal understanding to practice: How teachers transform their understandings of sustainability
RESEARCHER: *Sally Birdsall*

I have read the Information Sheet and understand why Sally is doing this research. I have had the chance to ask Sally questions and have them answered.

- I agree to take part in the research
- I know that it's okay to stop being part of the research up to two weeks after the start of the teaching and it won't matter because I will still be doing the same work as everybody else
- I want/do not want to be audio-taped when I talk about my poster
- I know that I can turn off the tape recorder at any time and it won't matter
- I want/do not want to be video-taped if I get chosen to be the leader of my group and talk about my group's ideas for solving the problem
- I know that Sally will make sure that nobody will recognise me when she writes her report
- I know that the ideas of everyone in the class should only be talked about in the class
- I know that Sally will look after all of the information and destroy it after six years

Thanks for taking part in this research.

Name:……..

Signed:……Dated:……

APPROVED BY THE UNIVERSITY OF AUCKLAND HUMAN PARTICPIANTS ETHICS COMMITTEE on 12 February 2010 for three years. Reference Number 2009/518

Appendix AC

Table showing the number of conceptual indicators given by each student teacher in their definitions of sustainability in the initial questionnaire

No Conceptual Indicators	1 Conceptual Indicator	2 Conceptual Indicators	3 Conceptual Indictors	4 Conceptual Indicators
ST3, ST10, ST38, ST39, ST70, ST71, ST72, ST73, ST74, ST75, ST76, ST77, ST84	ST4, ST5, ST7, ST8, ST9, ST11, ST12, ST14, ST15, ST16, ST18, ST19, ST20, ST29, ST30,ST31, ST33, ST34, ST35, ST36, ST37, ST40, ST41, ST43, ST44, ST45, ST46, ST47, ST48 ST49, ST50, ST51, ST52, ST54, ST55, ST56, ST57, ST58, ST59, ST60, ST61, ST62, ST63, ST64, ST65, ST66, ST68, ST78, ST80, ST81, ST82, ST85	ST1, ST2, ST6, ST13, ST17, ST32, ST53, ST67, ST79	ST83	ST42, ST69
13 student teachers	**52 student teachers**	**9 student teachers**	**1 student teacher**	**2 student teachers**
16.9%	**67.5%**	**11.7%**	**1.3%**	**2.6%**

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