The Use of Education for Sustainability Websites for Community Education in Chile

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ABSTRACT

An increasing recognition of the impact of human activity on the natural environment has oriented attention to the role of education for sustainability (EfS) as a means to create more ecologically literate and sustainable societies. One premise is that socio-ecological sustainability issues and challenges are immediate and locally rooted. This calls for educational interventions that promote participative action by local communities, recognizing that adults in those communities need to engage in action and change towards sustainability. In relation to this, current evidence indicates that Information and Communication Technology (ICT) and the Internet have the potential not only to promote teaching and learning for EfS, but also to increase knowledge, and promote attitude and behaviour change of individuals and the broader community.

In addition, sustainability issues are interrelated with other social dimensions with inherent complexity. Similarly, the design, implementation and use of ICT in education bring together learning and technology in complex ways. To address these types of educational contexts, both the ICT and EfS literature support a holistic and systems thinking approach. This suggests that developing a theoretical framework that informs the development of EfS websites, based on a systems thinking approach, might be an effective way to enhance ecological literacy, and action competence for socio-ecological sustainability at the community level. Within this context, this PhD research study aimed to investigate the use of Internet websites for community EfS in Chile.

A theoretical model for the design and development of EfS websites aimed at the community and non-formal level was developed based on literature from EfS, systems thinking, ICT, and community education. This model was trialled in an authentic context in Chile, through the design and build of an EfS website addressing the ecological sustainability issues of a lake, and its impact on the local community and visitors. Key considerations of this model relate to a deep understanding of the local, social and cultural

characteristics and needs of the target community, and associated sustainability issues; the use of culturally meaningful ICT affordances such as multimedia, Web 2.0, and social networking tools; and the inclusion of EfS pedagogical considerations and strategies for learning, such as promoting ecological literacy, critical thinking and action competence through knowledge integration and challenging beliefs.

Within a naturalistic paradigm, using an interpretive methodology, and following an activity theory analytical framework, the evaluation of the use of the EfS website by 24 local participants was conducted through the following research design. Firslty participants were administered a pre-intervention questionnaire, which assessed participants' prior knowledge related to ICT use, and to local sustainability issues. Immediately after they were invited to visit and browse the EfS website for a period ranging between 10 to 20 minutes. Following participants' use of the EfS website, a post-intervention interview explored participants' perceptions, understanding change, and motivations to take action. Finally, a follow-up online survey assessed participants' change in understanding, actions, and adoption of sustainable living principles, based on revisits to the EfS website during a period of five weeks, five months after their first visit.

Findings indicate that EfS websites are culturally shaped tools with the potential for facilitating transformative understanding processes, and empowering community members in engaging in action and participation towards socio-ecological sustainability at the local community level. A key aspect of the successful use of EfS websites for community education is to achieve meaningfulness and relevance through the website on local community members. Different considerations from the theoretical model appeared to have contributed to the achievement of such relevance in the Chilean community addressed in this study. These are fully presented and explored in the coming chapters. The expected contribution of this study is to inform the literature on the effective use of ICT to enhance practice of EfS at the community level.

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CHAPTER 1 - INTRODUCTION

1.1 Introduction

This research study investigates the effective use of Information and Communication Technology (ICT) to assist education for sustainability (EfS) at the community level. The focus is on the potential use of EfS websites at the non-formal level in Chile, as a means to address local socio-ecological sustainability issues by empowering community members through education.

The first part of this chapter introduces the conceptual background and rationale for this study, and the researcher's personal background and motivation to carry out this inquiry. This is followed by a general overview of the contexts of the inquiry, which includes current issues in the fields of EfS and ICT in Chile, and within the Chilean target community. The research questions guiding the inquiry process of this study are then presented. Finally, the relevance of the research topic to the field of education for sustainability is discussed, and a brief overview of the chapters following this introductory chapter is provided.

1.2 Rationale for this study

Our planet is facing major social and ecological sustainability issues (Intergovernmental Panel on Climate Change [IPCC], 2007; Lovelock, 2006; Myers & Kent, 2005; United Nations [UN], 2012). The reasons for, and causes of, these issues are several and varied, but all have a common effect. They are affecting the planet's natural ecological balance (Hossay, 2006; United Nations Environment Program [UNEP], 2013). The magnitude and complexity of these socio-ecological sustainability issues are such that they have been recognized as a "global crisis" for over 20 years (Orr, 1992, p. 19). Elements of human culture and development are regarded as one of the main factors contributing to this 'sustainability problematic' (Harris, 2004a). Moreover, as the natural environment and human society are interrelated, this crisis is not only affecting the

environment and the planet's ecological systems, but is also impacting on human communities (Myers & Kent, 2005; UN, 2002b).

The following problems and issues related to the current sustainability of the planet have been reported in the international literature: climate change; depletion of natural resources; ozone depletion; land-use management; deforestation; desertification; glaciers melting; soil loss and erosion; waste disposal; water, air, land and noise pollution; toxic and radioactive contamination; energy use; mass extinction of species; loss of biodiversity; population growth; poverty; famine; war; economic inefficiencies; international security; social decay and social injustice (Hossay, 2006; IPCC, 2007, 2008; International Union for Conservation of Nature [IUCN]/UNEP/World Wide Fund for Nature [WWF], 1980, 1991; Myers & Kent, 2005; Orr, 1992, 2004; Parliamentary Commissioner for the Environment [PCE], 2004; UNEP, 1992; United Nations Educational, Scientific and Cultural Organization [UNESCO]-UNEP, 1976). This substantive and extensive list of sustainability-related issues reflects the actual condition of the world, making an impact not only for human societies, but also for all living and non-living things that constitute the web of life on Earth (Capra, 1994; Lovelock, 2006; Stone & Barlow, 2005). All of these issues are somehow related and threaten the sustainability of our natural and social systems.

Since the recognition of these ecological and social issues, international literature has emphasized education, and particularly education related to the environment and to sustainability, as an effective way to address the sustainability problematic (Huckle, 1991; IUCN/UNEP/WWF, 1991; Orr, 1992; PCE, 2004; Sterling, 1996; Tilbury, 1995; UN, 2002a; UNEP, 1972, 1992; UNESCO, 2006; UNESCO-UNEP, 1978). Education has the potential to both challenge the present unsustainable conditions, and to "establish new paradigms of thinking and behaviour" towards sustainable ways of living (Fagan, 1996, p. 144; Tilbury & Wortman, 2008).

The role of education in addressing this challenge began to be promoted during the late 1960s, and has been an increasing concern since then. This is reflected in the development of environmental education (EE), education for sustainability (EfS), and all other related educational approaches that call for a type of education "by which human beings and societies can reach their fullest potential" (United Nations Conference on Environment and Development [UNCED], 1992, p. 1). In particular, *Agenda 21* (developed during the Earth Summit in Rio de Janeiro in 1992, see Section 2.2.4) not only called for education for sustainability across all educational sectors (i.e. formal, non-formal and informal levels), but specifically highlighted the importance and need of education for sustainability at the community and non-formal level.

Nonetheless, it has also been recognised that, although there are relatively high levels of general awareness about the existence of these sustainability issues among the general public, there is still a lack of knowledge and understanding about them (Bolstad, 2003a; McLean, 2003; Orr, 2004; Oulton & Scott, 2000; Sterling, 2001; Walker, 1997). This poor understanding of the issues related to sustainability challenges has been argued to be due to insufficient educational initiatives undertaken so far, meaning that many issues and problems remain (Chapman & Eames, 2007; Fien, 1997, 2000; Huckle, 1991; Walker, 1997). In this context, there is growing evidence that Information and Communication Technology (ICT), particularly the Internet and the use of websites as a dissemination tool, has the potential to improve learning in non-formal educational contexts (Barrel, 2001; Nicolaou, Korfiatis, Evagorou & Constantinou, 2009; Nomura, 2004; Somekh, 2007). Therefore, the Internet and the use of websites could be a significant tool to enhance education for sustainability programmes in non-formal settings (Aivazidis, Lazaridou, & Hellden, 2006; Nomura, 2004; Vrasidas, Zembylas, Evagorou, Avraamidou, & Aravi, 2007).

Since the late 1980s and early 1990s, ecological and sustainability issues have been recognized as also interrelated with other complex dimensions,

such as society and economics (UNEP, 1992; World Commission on Environment and Development [WCED], 1987). This shift towards complex 'interrelatedness' between the environmental, economic, and social dimensions points to a need for a new approach in EfS towards ecological sustainability. In a similar way, ICT is regarded in the literature as an innovation in progress and development that brings together learning and technology in complex ways. Considering both the implementation of ICT in education and the provision of education for sustainability (EfS) as complex and unpredictable processes, the adoption of a holistic, multidisciplinary and systems thinking approach, with emphasis on the relations and connections in the different components and dimensions, is highlighted and supported in the literature (Belshaw, 2001; Bolstad, Cowie, & Eames, 2003; Huckle & Sterling, 1999; Orr, 2004; PCE, 2002; Somekh, 2007; Sterling, 2001; Tilbury, 1995; WWF, 2005).

This background suggests that addressing sustainability issues and challenges using ICT tools, such as the Internet and websites, might be an effective way to enhance non-formal education for sustainability programmes at the community level. In addition, a systems thinking perspective appears as a potential approach for research on the use of ICT for EfS. The technology, access and penetration of the Internet is increasing worldwide, as is the sophistication of websites and multimedia features that further facilitate this process (Caladine, 2008; International Telecomunication Union [ITU], 2013; Kling, 2000). As such, the Internet has shown promise to enhance the access to information by the general public in many countries of the world (Keeble & Loader, 2001a; Nicolaou et al., 2009; Organization for Economic Co-operation and Development [OECD], 2006; Somekh, 2007).

Based on the above, the objective of this study was to investigate the effective use of ICT for community EfS, in particular, the use of EfS websites to promote both understanding and action for socio-ecological sustainability at the community level in Chile. More details on this target country, and the target community, follows in Section 1.4, and in Chapter

5. The next section presents the personal background of the researcher motivation for doing this study.

1.2.1 Personal journey of the researcher

At a personal level, different factors have motivated me as the researcher to pursue this study. In the first place, throughout my life I have had the chance to be in close contact with nature. Whether in my home country Chile, or in other places, the natural world has always fascinated me. The biogeography of Chile is so varied and unique that, aside from a tropical climate, all other climate types can be found in the country. From dry and hot deserts, to cold and icy mountains, to endless coastlines, this natural beauty characterizes Chile. This passion for the natural environment of my country, and all living things within it, took me to study a BSc in Biology.

A deep interest in the intercommunication process existing between living organisms, as well as within themselves at the individual level, had me following a neuroscience path during the first stages of my Biology studies. From such a position I learned about the complexities and harmony of neural networks, which are at the basis of our relationship with the environment. Although I still have great interest for this field, a series of more environmental, ecological and outdoor-related papers had me turning my main interests towards the biology of ecological systems. Personally I consider that many of the more systemic and cognitive perspectives and approaches of neurobiology fit within the field of ecological systems (and of ICT). But what had me turning my attention to the field of education, and in particular education for sustainability, was that in such environmentally focused papers, many of my lecturers repeated over and over that practically all Chile's natural and ecological sustainability problems and issues were related to a lack of environmental education and culture in our country.

It then became obvious, as a biologist, that to preserve and conserve the natural environment of Chile, many efforts were needed in terms of educating the people of my country about the rich biodiversity that

characterizes the different corners of Chile, and the challenges we face for its conservation. This increasingly unfolded my current passion for education for sustainability, which I consider a powerful tool to achieve a more socio-ecologically sustainable society, both in Chile and elsewhere.

At the same time, and due to different historical factors, since the 1990s Chile has been characterized as a leading country in Latin America regarding development of ICT infrastructure and penetration of the Internet (Donoso & Roe, 2006). This has been further enhanced by a countrywide initiative promoting the implementation of ICT in the Chilean formal curriculum, including ICT infrastructure and support (Hinostroza, Hepp & Laval, 2000). In practical terms, for me it has been common to be in contact with technology, ICT and the Internet since my secondary schooling days. This is why the fact of using ICT and the Internet to support EfS initiatives at the community level is obvious, logical, and evident to me, under the assumption that through ICT it would be easy and cost-effective to access learners in Chile. This is what brought me to study the effective use of ICT for community EfS. The next section further explores the contexts of the inquiry of the present study.

1.3 The context of inquiry

This section addresses the context of the present research. This includes an overview of education for sustainability and ICT in the Chilean context, followed by aspects related to the use of an EfS website in the target community of this research.

1.3.1 Education for sustainability in Chile

Isolated scholars and naturalists raising concerns over the evident degradation of the natural environment from anthropogenic activity characterized the early stages of the environmental movement in Chile. The principal concerns then were related to the loss of biodiversity, land and soil use, indiscriminate logging of native forests, and the disposal of hazardous waste from the mining industry (Omegna, 2003). Omegna further points out that during the early 1970s, due to rising global concern,

the environment as a concept was permanently present in the media, with calls for greater awareness of environmental and ecological issues in the country from different sectors. Until the return to democracy in 1990, concern for the environment was not a matter of State but was rather a social concern, with different private and public initiatives and groups raising awareness and taking action. In 1994 the first environmental law addressing integrative aspects related to environmental issues was promulgated. This was the starting point of a new phase for the ecological and environmental movement in Chile, with the creation in 1997 of the first governmental department dedicated to education for sustainability (Abogabir, 2003; Fuentealba, 2005).

In terms of the levels of awareness and of ecological literacy of the general public in Chile, there are different indicators that suggest a moderate to high level of awareness of environmental issues, but a low level of ecological literacy and of understanding of sustainability issues (González-Gaudiano, 2007; Liberona, 2008; Ostuni, 2006). Historically, environmental education (EE) and EfS initiatives have been few and dispersed, with a more recent growing interest (Fuentealba, 2005). From a socio-ecological sustainability perspective, this represents a problem because a low level of ecological literacy could directly or indirectly affect the quality of the natural environment, which in turn might affect the quality of life of Chilean communities (Abogabir, 2003).

Nevertheless, since 2002 the Chilean government has been implementing a system of environmental certification for schools, or eco-schools, where the aim is to integrate EE into the curriculum and school life in a sustainable way (Omegna, 2003). According to Prosser (2007), a Chilean environmental educator, after the first three years of this certification system, the great majority of certified schools were presenting high levels of achievent (of integration of EE into the curriculum) during their evaluation, with an evident individual and collective thinking change towards sustainability. More recent reports indicate that Chilean eco-schools are growing in number throughout the country, including examples

where the private sector supports more vulnerable and isolated schools, such as, for example, the case of a group of rural schools in Andacollo, a mining area in the North of Chile (Maturana, 2013).

These reports of the promotion of EE and EfS within the Chilean curriculum are promising for the ecological literacy of future generations. However, one of the premises guiding this study is that sustainability issues are immediate and require action today (Tilbury & Wortman, 2008), which calls for the promotion of EfS initiatives at the community level.

1.3.2 Information and Communication Technology in Chile

On the ICT side, Chile is characterized within Latin America as an economically wealthy country that has been able to develop its technological and ICT infrastructure in a successful way during the past 20 years (ITU, 2012). In particular, this country is characterised by a high level of ICT and Internet penetration and social use of digital tools (APEC Digital Opportunity Center [ADOC], 2011; Donoso & Roe, 2006; Everis, 2011).

In addition, and as mentioned earlier, Chile has been successfully implementing ICT within the educational curriculum and educational formal system for over two decades, through the *Enlaces* program (which literally means 'links') (Hinostroza, Hepp & Cox, 2009). This Chilean ICT in education experience has been highlighted in the literature as a successful one, characterized by its harmonious and whole-approach implementation of ICT at different levels, including technology infrastructure and access, skills development, and constant technical support (Hinostroza, Hepp & Laval, 2000; Somekh, 2007; Sunkel & Trucco, 2012). The Enlaces program has contributed to the high levels of ICT skills and use present in Chile, when compared to other countries of the Latin America region (ITU, 2012; Sunkel & Trucco, 2012).

The Chilean technological and ICT contexts and background provides a good base for research on ICT, principally due to the high penetration of

ICT technology and infrastructure, as well as the high levels of social access and use (ITU, 2012).

1.3.3 Use of EfS websites for community education in the context of the Lanalhue Lake in Chile

Three key conditions were needed to be present in order to choose the target community of this study: (1) the existence of a socio-ecological sustainability issue affecting the wellbeing of the local community; (2) the presence of a reliable ICT infrastructure (e.g. Internet access and use); and (3) an evident need for an EfS intervention. Considering that indicators suggest a relatively low average level of ecological literacy in Chile, which calls for EfS interventions (González-Gaudiano, 2007; Liberona, 2008; Ostuni, 2006), and that penetration and use of ICT and the Internet is relatively high countrywide (ADOC, 2011; ITU, 2012), any community presenting a socio-ecological issue was a potential target community. Based on logistic factors, and on the prior knowledge of the researcher of this community, the socio-ecological context at the Lanalhue Lake in Chile was chosen as the target community for the intervention of this educational research study.

The principal ecological sustainability issue present at the Lanalhue Lake affecting the local community and visitors is the accelerated eutrophication process in the lake. This is due to an increase of organic nutrients in the waters of the lake from anthropogenic sources, such as agriculture, forestry industry, tourism industry, and urban development, which has produced deep effects at the ecological and social level (Bardón, Cienfuegos & Sperberg, 2006; Lanalhue Sustentable, 2011). In terms of ICT and EfS, an evident need for an EfS intervention was recognized at the local level to address the eutrophication of the lake (Comité Nacional Pro Defensa de la Flora y Fauna [CODEFF], 2007; Comisión Lago Lanalhue, 2007), and satisfactory ICT and Internet penetration and access was present in the area (Subsecretaría de Telecomunicaciones [SUBTEL], 2013). In addition, no other website was found to target and address this socio-ecological issue, making the EfS website developed as part of the

intervention of this study an innovation at the local level, and a contribution to the local community. More information about this target community and the intervention phase follow in Chapter 5. The coming section presents the research questions driving this inquiry on the use of ICT for community EfS in Chile.

1.4 Research questions

Having presented the rationale, the personal motivation, and the contexts of inquiry of this study, this section introduces the questions guiding the research. As mentioned before, the aim of the present research was to understand the effective use of ICT to enhance education for sustainability (EfS) at the community level. In particular, the objective was to evaluate the use of EfS websites for the promotion of understanding and action for socio-ecological sustainability among local community members of the target community in Chile. The research questions that guided the selection of a study methodology, a set of methods for data collection, and the research design of the intervention, were the following:

Research question:

> Can the use of websites assist non-formal education for community understanding of sustainability issues in Chile?

Research sub-questions:

- What ideas could be used to design an EfS website to promote understanding and action for sustainability at the community level?
- How do community members use an EfS website and what for?
- Does the use of an EfS website improve understanding of sustainability issues among community members?
- Does the use of an EfS website promote action, and adoption of sustainable living principles among community members?

The principal goal of this study was to address these research questions. In order to address the main research question, the set of four sub-questions needed to be evaluated first, as they inform the main question.

The first sub-question addressed theoretical considerations and ideas from the literature that informed a theoretical model for developing EfS websites, presented in Chapter 3. Based on this model, during the intervention of this study an EfS website was designed (see Chapter 5) to serve as the research instrument to address the remaining three sub-questions.

The second sub-question aimed to understand the type of use of an EfS website by community members (i.e. the 'how' of the use of an EfS website by community members), and the purpose of using the website (i.e. the 'what for' of the type of use). The last two sub-questions evaluated if the use of such an EfS website can promote understanding, and action, around local sustainability issues affecting the target community. By addressing these research questions, an understanding of the effective use of Internet websites to assist community EfS in Chile was aimed to be achieved, including the characteristics and different aspects associated with such an educational process. In the next section, the significance of this research is presented.

1.5 Significance of the research

Internationally, the environmental issues that we are living with (e.g. climate change), the notion of ecological sustainability and of sustainable development, and the concept of education for sustainability (EfS) are all regarded as highly important and relevant areas. This is confirmed by international efforts such as the 'Decade of Education for Sustainable Development (2005-2014)' (DESD), launched and promoted by the United Nations (UN, 2002b), and by the international discourse surrounding global warming and climate change (IPCC, 2007; IUCN, 2002; UN, 2012; UNESCO, 2006). Likewise, the use of Information and Communication Technology (ICT) for educational purposes is considered a key area and is highly supported in different educational systems around the world (Becta, 2008; OECD, 2006; Plomp, Anderson, Law & Quale, 2009). In relation to this study, there is little literature addressing the combination of EfS with

ICT, in particular within a systems thinking approach as in this research, which reflects the novelty of this study.

Concerning Chile, there are many indicators that suggest the presence of social and ecological sustainability issues that need to be addressed (Comisión Nacional de Medio Ambiente [CONAMA], 2010; Comisión Nacional de Investigación Científica y Tecnológica [CONICYT], 2010; WWF, 1999). Examples of this are the high levels of urban pollution and natural soil degradation, and the almost non-existent recycling culture, although, from a personal perception point of view, there has been an improvement in general terms of the environmental culture in Chile over the past decade. In this context, and as stated earlier, educational initiatives have been historically few and dispersed, with only a more recent growing interest, resulting in a relatively low level of ecological literacy among the general public (González-Gaudiano, 2007; Omegna, 2003). In addition, the high rate of computer penetration and Internet access existing in Chile (Donoso & Roe, 2006) places Chile as a favourable setting for research in ICT and EfS, and as a relevant location for the implementation and practice of EfS community initiatives.

Based on such background, this PhD research is significant because it aimed to extend the theoretical and practical knowledge existing in relation to the use of ICT for EfS; and to assist with the development of sustainable communities in Chile. The innovative aspect of this research is that it brings together different fields of knowledge, such as ICT, EfS and community education, into a theoretical model for the development of EfS websites. Such a model incorporates different crossovers between these fields of knowledge, underpinned by a systems thinking approach, and aimed at promoting understanding and action for sustainability.

In addition, it is assumed here that the existing relationships between the natural ecological environment and human culture are configured in such a way that perturbations in one of these inexorably affect the other. Within this view, the quality of a particular natural environment will determine the

quality of life of the associated human communities. From an environmental, ecological, and social justice point of view, to aim for the sustainability of socio-ecological systems is ethically mandatory. It is argued in this thesis that community-based EfS by means of Internet websites might be an effective way to achieve such socio-ecological sustainability at the community level. The next section presents an overview of the chapters addressing the different issues related to this research thesis.

1.6 Overview of the thesis chapters

This PhD thesis is composed of nine chapters. Chapters 2 and 3 address the literature review relevant to the present research. Chapter 2 covers key aspects of relevant literature from education for sustainability, systems thinking, ICT, and community education. The focus of Chapter 2 is to identify key ideas and considerations from these areas of knowledge to inform the theoretical model for developing EfS websites for community education, which is presented in Chapter 3. Then follows Chapter 4, which presents the methodology of this educational inquiry. Based on the research questions guiding this study, an educational research paradigm, methodology, and set of methods were selected along with a research design specifically planned to address those research questions.

Chapter 5 presents the target community of this study, the socio-ecological context of the Lanalhue Lake in Chile. The first part of the chapter includes an overview of the social, ecological, and technological backgrounds and contexts of the target community. The second part presents the application of the theoretical model from Chapter 3 within the socio-ecological context of the Lanalhue Lake, highlighting different theoretical and practical aspects related to the development of an EfS website addressing the target community. Based on the EfS website that was then used as the research instrument, Chapters 6 to 8 present the findings of this research, in terms of the investigation of the use of an EfS website to promote understanding and action for socio-ecological sustainability at the community level, as well as the adoption of

sustainable living principles and practices by local community members. Finally, Chapter 9 presents the discussion and conclusions of this study, highlighting the limitations, implications and recommendations related to the use of ICT for EfS at the community level.

CHAPTER 2 - LITERATURE REVIEW

2.1 Introduction

In this literature review, the ideas and perspectives concerning the use of ICT for EfS presented in Chapter 1 are further examined, situated, and discussed. Following this introductory section, Section 2.2 continues with consideration of the concept of 'sustainability', around the notion that the environmental and social issues facing the planet need to be addressed as a *sustainability* problem. In addition, some characteristics and issues related to different education approaches to sustainability are examined. Following this, Section 2.3 reviews the concept of systems thinking, which helps situate the sustainability problematic within a systemic context. This approach includes emphasis on the relationships between the different dimensions of socio-ecological sustainability issues.

The fourth section of this review (Section 2.4) addresses the concept of Information and Communication Technology (ICT). Here the focus is on how ICT, the Internet and websites can constitute educational tools to support education for sustainability (EfS) programmes at the community level. Key issues associated with the use of websites for community EfS are the importance of the consideration of the socio-cultural context and ICT infrastructure of the target audience, in order to design meaningful community-based EfS websites.

Following this, as the underlying position here is to address the sustainability problematic by fostering understanding and action amongst the general public (i.e. community members), Section 2.5 reviews the characteristics of non-formal and community-based education. Community education is the type of education (i.e. either formal, informal or non-formal education) that occurs within the community (Galbraith, 1990b). Community education is regarded in the literature as an important means to engage people and communities towards more sustainable ways of living (Fagan, 1996; Tilbury & Wortman, 2008). In this respect, it is argued in Section 2.5 that non-formal community education might promote both

understanding and action towards sustainable ways of living. Finally, the last section of the present chapter (Section 2.6) summarises the key ideas and concepts presented and reviewed throughout this literature review. These ideas will provide indications on the key theoretical considerations to be integrated in the development of a theoretical framework for the development of community EfS websites, based on concepts and notions of ecological sustainability, systems thinking, ICT, community education, and education for sustainability (EfS) learning approaches.

2.2 Sustainability and education

In this section the notion of 'sustainability' is reviewed. Since environmental, economic and social issues and problems facing the world are often framed as 'sustainability' issues, it is of interest to address this concept and to set it within the context of this research. Depending on the standpoint, the concept of sustainability can be interpreted differently, sometimes even including contrasting underlying principles. Also, adjectives such as 'weak' and 'strong' may be found in the related literature. Nonetheless, a common point, even between dissimilar views, is that the concept of sustainability encompasses the idea of interrelatedness between the different human, environmental, social, economic, and cultural dimensions.

This section begins with a review of sustainability problems and unsustainable practices, with attention to their causes and some possible solutions, and highlighting the need for thinking in terms of sustainability. Following this, some definitions of sustainability present in the literature are introduced. In the third part of this section, different models and perspectives of sustainability are reviewed and examined. Based on these definitions and perspectives from the literature, the 'definition' of sustainability, as it is understood in this review, is presented. Finally, the last part introduces the concept of education for sustainability (EfS), with a focus on how this educational approach can be effective in addressing sustainability issues facing the planet today.

2.2.1 Sustainability and sustainability challenges

When adopting an evolutionary perspective, the Big Bang (i.e. Big Bang theory) and the consequent formation of the Universe as humankind knows it occurred 15 billion years ago; the formation of the solar system and of planet Earth about 4.6 billion years ago; the first cell fossils are dated to 3.6 billion years ago; and the *Homo sapiens* species appeared between 3 to 40 million years ago, which only represents 0.01% of the Earth's history (Myers & Kent, 2005). This analysis shines a light on the temporal dimension of life on planet Earth since it appeared and evolved in a natural and dynamic balance to what we know and see today. In 1830, there were approximately 1 billion people living on planet Earth, whereas in 2003 the number of people was over 6 billion; and it is projected that by the end of the present century the number of people will increase to 9.2 billion (Myers & Kent, 2005; UN, 2013).

It has been suggested in the literature that one of the main root causes of current sustainability issues is this growth in the number of people consuming more and more ecological resources, goods and services (Hossay, 2006; Myers & Kent, 2005; Sustainable Aotearoa New Zealand Inc. [SANZ], 2009). Similarly, it is suggested that the *way* people consume these goods and services is another important root cause of today's sustainability problems (Cartwright, 2009; Lovelock, 2006; Orr, 2004; SANZ, 2009). In other words, from some perspectives, sustainability issues and challenges are rather related to over consumption of natural resources by means of unsustainable social, political and economic practices, and to population growth, both putting enormous pressure on the planet's ecosystems and related human communities (Myers & Kent, 2005; SANZ, 2009; UNESCO, 2006). In relation to this, and taking a similar evolutionary perspective as above, Myers and Kent (2005) report that since 1950:

> Humans have drastically altered almost half of all ice-free land, ruined a third of cropland, and appropriated over half of the available fresh water. They have doubled the fixation rate of Nitrogen over natural sources, bringing on massive pollution, and

> have destroyed half of tropical forests. They have effectively extinguished hundreds of thousands of species. They have increased carbon dioxide in the atmosphere by almost a third, eventually causing severe dislocations in global climate. These changes have levied costs of trillions of dollars per year.
>
> (Myers & Kent, 2005, p. 18)

From a natural resources consumption perspective, the changes induced by humankind over the environment have occurred "within a flicker of evolutionary eye", in comparison to other natural changes of similar proportions (e.g. changes in the composition of the atmosphere) (Myers & Kent, 2005, p. 14). Related to this, the 'world's ecological footprint', which is a measure of humanity's use of renewable natural resources, "grew by 80 per cent between 1961 and 1999, to a level 20 per cent above the Earth's biological capacity" (WWF, 2002, p. 2). For the first time in history, the world's ecological footprint went to an overconsumption state, and is expected to attain levels equivalent to two planet Earth's natural threshold by 2030 (WWF, 2006, 2012). In other words, humankind today consumes significantly more than what the planet's natural capital can provide, clearly exceeding the natural capacity threshold and depleting the Earth's ecosystems (Daly, 1992; WWF, 2006). This creates sustainability problems and conflicts derived from different interests over the management and use of these ecosystem services and goods (Hossay, 2006; Myers & Kent, 2005).

Concerning the economic practices underpinning sustainability issues, these are founded under the premise that 'continuous growth' (i.e. also called 'standard growth', see Figure 2.1) is possible, as an economic practice approach, based on the assumption of constant availability of natural resources and on the 'zero' cost of the natural capital (Brown, 2008; Daly, 1992; SANZ, 2009). Such an economic approach is often called in the literature a 'utilitarian' economy, as it is based on a utilitarian ethic: in the Western tradition "utility (happiness) is held to be directly related to material income and wealth, and individual self-interest is

assumed (‘economic man’). Economic growth is seen as the only way to achieve more utility”, while the natural environment only has an instrumental value (SANZ, 2009, p. 11). This utilitarian ethic, which underlies the Western worldview of economic growth, is argued to be a “perverse” economic approach (SANZ, 2009, p. 6), by not taking into account the responsibility of human action towards the natural environment (Capra, 2008; Dresner, 2008; Orr, 1992).

As a response to the utilitarian economy, and to its ‘continuous’ or ‘standard growth’ approach, Herman Daly (1992) proposed the ‘steady-state’ economy approach (see Figure 2.1), which assumes that “depletion [of natural resources] and pollution are costs, and naturally they should be minimized for any given level of stocks to be maintained” (p. 17). The steady-state economic approach recognizes that the world’s economic activity has to fit within the constraint boundaries determined by the ecosystem services’ capacity. In addition, it is both argued that such an economic approach is necessary to achieve a sustainable society, and that in order to attain a steady-state economic model, a “shift in societal ethics and values” is required (SANZ, 2009, p. 11; Sterling, 2001).

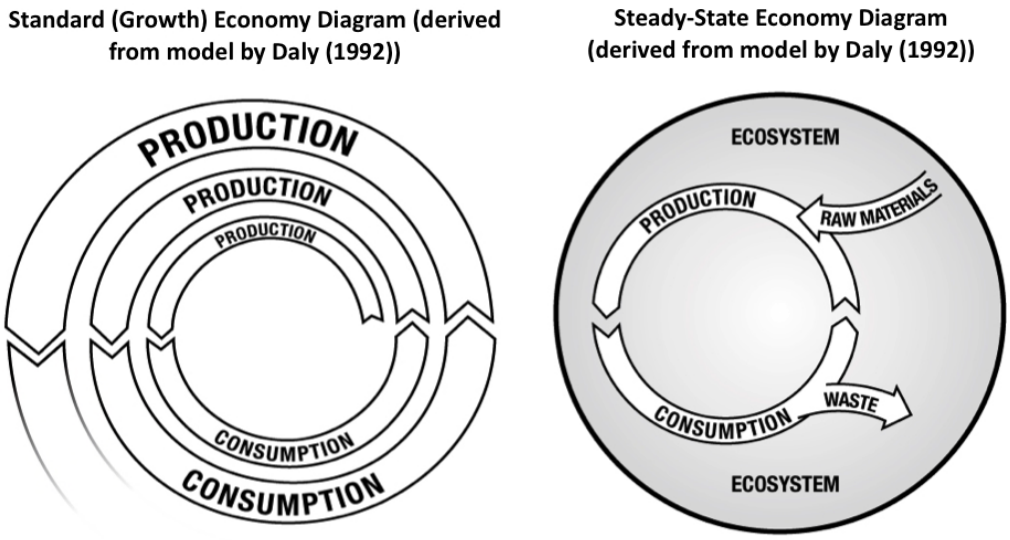

Figure 2.1. The ‘standard growth’ and the ‘steady-state’ economic models, based on Daly (1992) (source: Cartwright 2009).

Moreover, the steady-state perspective clearly defines the notion of natural 'optimum stock', derived from the sum of services from the economy and from the ecosystems, which then establishes a clear consumption maximum of ecological services and goods (Daly, 1992). In the words of Herman Daly, "minimizing future regret is wiser than maximizing present benefit" (Daly, 1992, p. 35). Compared to the 'standard growth' economy, the 'steady-state' model acknowledges that "all real systems" are open, therefore, from a systems thinking perspective, they are subject to continuous flows of matter and energy within certain limits (e.g. ecosystem boundaries) (SANZ, 2009, p. 17). This flow of matter and energy is represented by input of 'raw materials' and output of 'waste' in the 'steady-state' diagram in Figure 2.1.

So far, it has been argued here that the world is facing major ecological sustainability issues and challenges. Regarding this, the magnitude and scale of these sustainability problems are significant, for which there are calls for immediate and unconditional actions at all levels (Myers & Kent, 2005; Stern, 2006; UNESCO, 2006; WWF, 2012). Concerning this, different organizations, institutions, and scholars plead for the need for a shift in principles, values, and paradigms towards a more 'strongly' sustainable world (Capra, 2005b; IUCN/UNEP/WWF, 1991; Lovelock, 2006; Ministry for the Environment, 2008; Myers & Kent, 2005; Orr, 1992, 2004; Sterling, 1996, 2001; SANZ, 2009; UNCED, 1992; UNESCO, 2006). An example of such a thinking and approach shift in the realm of economy is to change measures of economic development and performance, from GDP (i.e. Gross Domestic Product, largely used in today's global economy) to 'community wellbeing and happiness' factors, highlighting their integrity with ecological systems (Cartwright, 2009).

Furthermore, and as one of the possible solutions, the need to address environmental and sustainability issues has turned the attention to the role of education, and particularly education for sustainability (EfS), as a means to create a more ecologically literate citizenry, which is believed to be at the base of the realization of a more sustainable world (Orr, 1992,

2004; PCE, 2004; Sterling, 2001; UNEP, 1992). The issues regarding the role, characteristics and importance of EfS follow in Section 2.2.4. Prior to that, an attempt to define the concept of sustainability as understood in this study follows.

2.2.2 Defining the concept of sustainability

As mentioned earlier, during the late 1980s and early 1990s global environmental, social and economic issues were increasingly recognised as interrelated. This shifted the attention from 'environmental concerns' to 'sustainability' or 'sustainable development' concerns (Daudi & Heimlich, 2002; Harris, 2004b). To some people, these two latter terms have different meanings, however, for the purposes of this review they are grouped under the term 'sustainability'. In relation to this, it is argued that because of the broad array of disciplines dealing with 'sustainability', different definitions and interpretations of this term can be found, depending on the values and goals that underpin each of these disciplines (Chapman & Eames, 2007; Harris, 2004b; PCE, 2002; Räthzel & Uzzell, 2009). As an example, Dresner (2008) states that "different people use the term in different ways, some emphasizing development through economic growth, and others emphasizing sustainability through environmental protection" (p. 2).

This broad range of use of the sustainability term "has meant that it is increasingly hard to define", and that in order to understand the concepts behind this term, the first question to ask should be "what is to be sustained?" (Harris, 2004b, p. 267). In relation to this, some scholars argue that, as the origin of the sustainability issues can be traced to an overuse, degradation and over consumption of ecosystem services and goods, what is to be sustained is the integrity of the planet's ecosystems and their ecological balance (Capra, 1994; Dresner, 2008; Lovelock, 1979; 2006; Myers & Kent, 2005).

Concerning the definition of sustainability, Corney (2006) reports the presence of a growing consensus in the literature in that any definition of

sustainability needs to centre the attention on the interrelationships existing between the different dimensions of sustainability (i.e. environment, society, and economics). Additionally, 'future' and 'long-term' are ideas and concepts that also appear as essential components of the definition of sustainability (Walshe, 2008). This is because actions undertaken today might have sustainability-related effects in the future, and thus, long term thinking is required in order to minimize negative effects (Myers & Kent, 2005; Orr, 2004). Regarding the notion of interrelationships, or interrelatedness, between the environment, economics, and society, the Parliamentary Commissioner for the Environment (PCE) of New Zealand stressed "the need for decision-makers to think in terms of 'systems' rather than focusing only on the component parts when seeking sustainable solutions" (PCE, 2002, p. 34). This 'systems thinking' idea is further explored in the coming sections of this review (Section 2.3).

All the matters presented above reflect the discourse and discussions about what is sustainability and how it may be defined. As this concept has evolved, different perspectives and interests have resulted in different meanings. However, common elements and ideas do arise and merge, such as 'relationship', 'interrelatedness' and 'long term', as well as 'social equity' and 'social justice'. In order to further investigate the sustainability concept, the coming section presents different models and perspectives of sustainability. The exploration of these different models can assist in understanding what the differences between some contrasting approaches are, as well as to grasp how the notion of sustainability has evolved during the last two decades. This leads to the definition of 'sustainability' being used in this study.

2.2.3 Models and perspectives of sustainability

In 1987, The Brundtland Commission in its report *Our Common Future* introduced one of today's most well-known and used definitions of 'sustainable development' (Chapman & Eames, 2007; Hossay, 2006), as: "the ability of current generations to meet their needs without

compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987, p. 43). From this definition, the Brundtland model of sustainable development, also called the 'classic' model of sustainable development (see Figure 2.2), was derived as "an attempt to go beyond a narrow focus on the natural environment and to incorporate the three interlinked spheres of the environment, economy and the social into the goal of sustainability" (Räthzel & Uzzell, 2009, p. 265).

In relation to this, while attempting to distinguish between weak and strong sustainability around the notion of how sustainability should be achieved, Huckle and Sterling (1999) defined weak sustainability as the form where societal relations that created environmental and sustainability problems are retained. In contrast, "from a systems point of view strong sustainability necessitates a transition towards resilient social, political, economic and ecological systems which are diverse and durable, and these have to be rooted firmly in the locality and region" (Huckle & Sterling, 1999, p. 4). These authors highlight the importance of a shift in educational thinking and practice in order to achieve the transition towards a more sustainable society.

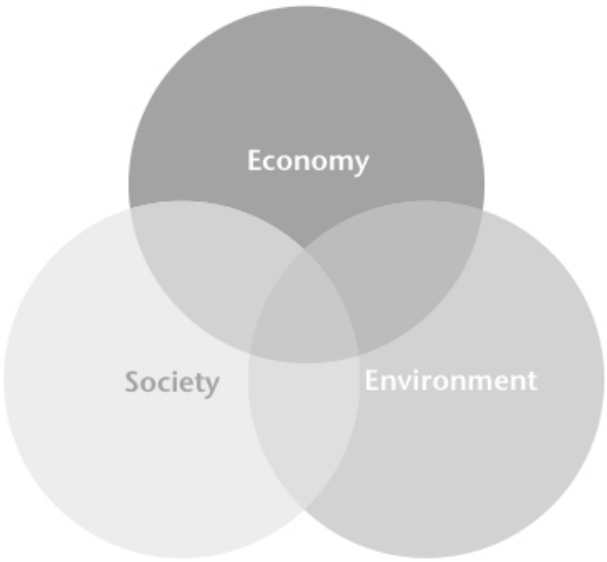

Figure 2.2. The Brundtland, or classic, model of sustainable development (source: PCE, 2002).

Regarding the use of the ‘weak’ and ‘strong’ characteristic while referring to sustainability models, some scholars in the literature regard the Brundtland model as weak, principally because the economic and society dimensions should not be outside of the environment dimension (Chapman & Eames, 2007; Räthzel & Uzzell, 2009). According to Sustainable Aotearoa New Zealand Inc. (SANZ), in this model “only the (usually tiny) intersection of the three circles represents the possibility of sustainability” (SANZ, 2009, p. 8). Furthermore, using the weak sustainability definition from Huckle and Sterling as a starting point, Räthzel and Uzzell (2009) identify at least three problems with the Brundtland model:

- First, the three areas are treated as separate entities, meeting only in the middle to form a harmonious whole.
- Second, the overlapping three elements suggest that a state of harmony can be achieved, while, if we accept for a moment the separateness of these dimensions, their relationship is one of conflict and contradictions rather than harmony.
- Third, analyzing the world by separating these three categories serves to encourage us to treat them separately and independently in practice as well

(Räthzel & Uzzell, 2009, p. 265)

Another model regarded as weak in the literature, and particularly from an economics point of view, is the BAU or ‘Business as usual’ model, also called the ‘Mickey Mouse’ model (see Figure 2.3). This model represents the classic model of sustainability (see the Brundtland model, Figure 2.2), but “at its worst”, where the economic dimension dominates the two other dimensions, representing how any possible sustainability intersection within dimensions is reduced and even can disappear (SANZ, 2009, p. 8). SANZ (2009) stresses that the BAU model of sustainability is the “current model that underpins most global economic and political decision making” (p. 8), and that the BAU model only leads towards exacerbated global sustainability issues.

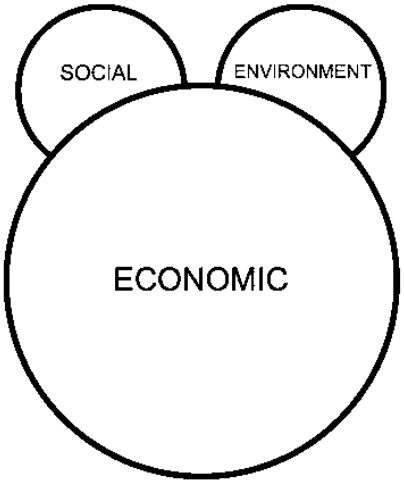

Figure 2.3. The 'Business as Usual' (BAU) model of sustainability, (source: based on Cartwright, 2009).

In another perspective, the model represented in Figure 2.4 shows a different set of relations between the environment, economy and society. This model, sometimes called the 'ecological' or 'strong' model of sustainability, considers the economy as a subset of society (i.e. under the assumption that without a society no economy can exist), and the society as a subset of the environment, simply because the "human society and the economic activity within it are totally constrained by the natural systems of our planet" (PCE, 2002, p. 35).

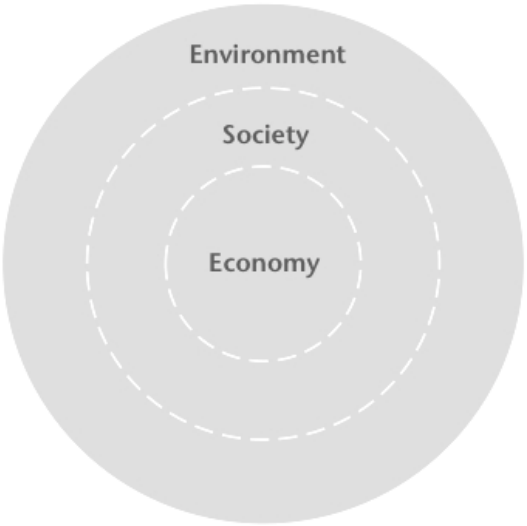

Figure 2.4. Ecological or 'strong' model of sustainability (source: PCE, 2002).

Nonetheless, Räthzel and Uzzell (2009) are reluctant to use the term ‘strong sustainability’ and view it as not ideal, because it does not provide clear goals or guidelines on how to achieve sustainability. Rather, they prefer the term ‘transformative sustainability’, where the notion of change of the social conditions and thinking that initially led to the actual environmental and sustainability issues is implicit (Räthzel & Uzzell, 2009). These authors go further and propose a new model, on the basis that societal relationships need to be regarded and integrated in a new way, proposing and defining three types of relations underpinning sustainability. These are: ‘relations of production’, instead of the ‘economy’; ‘relations of consumption’, which regards the marketing of products as “a more powerful and power-driven relation between consumption and production”; and ‘political relations’, where the process of decision making of political institutions need to be in accordance with the programme of transformation towards sustainability (Räthzel & Uzzell, 2009, p. 269).

In Figure 2.5, these authors represent what they call ‘the global body politic’, where the set of relations mentioned above “feed off, contradict and melt into each other, and constitute a global space that is fragile and in tension; it can merge into a whole but is also constantly in danger of falling apart” (Räthzel & Uzzell, 2009, p. 268).

Figure 2.5. The ‘global body politic’ model of sustainability (source: Räthzel & Uzzell, 2009).

From a systems thinking and educational perspective, Räthzel & Uzzell (2009) believe that the set of relations at the core of this model are what influences the state of the environment. Thus, to achieve transformative sustainability, a transformative education for sustainability (EfS) in this context should focus on understanding these relations, or what is also described as a *systems thinking* approach for EfS (Centre for Ecoliteracy [CEL], 2009b; Sterling, 2001; WWF, 2005).

In another perspective, in a reflection derived from the definition of sustainability from the Brundtland report, David Orr (1992) notes that two versions of sustainability can be derived from it. He defined them as technological sustainability, and ecological sustainability (Orr, 1992). According to Orr, the difference between these two versions of sustainability relies on whether sustainability can be achieved within the modern paradigm, through better technologies and more efficient economic policies, or whether a transition to a new, post-modern, paradigm is needed. In this context, technological sustainability is regarded as a means to address the actual conditions, or symptoms, of the Earth, based on the assumption that technological innovation will assist to solve the environmental crisis (Orr, 1992). In this regard, SANZ (2009) argues that technological innovation is small in scale and too late to assist in completely solving the sustainability issues.

On the other hand, the 'ecological sustainability' approach is more likely related to an exploration of new qualitative practices that might lead to sustainable living, giving a "different approach to technology, one that gives greater priority to those that are smaller in scale, less environmentally destructive, and rely on the free services of natural systems" (Orr, 1992, p. 94). This strong and ecological sustainability version and vision is similar to the ones expressed by Räthzel & Uzzell (2009) and Huckle and Sterling (1999), in the notion of the need for a transformation, or change, towards new kinds of practices to achieve sustainability. This is a vision shared by others in the literature (Chapman

& Eames, 2007; Comisión Nacional del Medio Ambiente [CONAMA], 2008; Tilbury & Wortman, 2008; WWF, 2005).

While trying to understand what human factors are contributing to sustainability issues, David Orr (2004) highlighted three main causes as evident: first, the political and societal decision-making systems of modern societies are short-term in their vision, rewarding unsustainable practices, and leaving long-term consequences as a problem for the future. In the words of Garret Hardin, from his essay 'The Tragedy of the Commons', "each man [sic] is locked into a system that compels him to increase his herd without limit - in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest" (Hardin, 1968, p. 1244).

Second, the economic growth of industrial societies, which is regarded as a government's performance indicator, and thus highly stimulated, has little regard to possible ecologically destructive effects of economic growth. And finally, at a deeper level, "the crisis of sustainability can be traced to a drive to dominate nature that is evident in Western science and technology", founded in a mechanistic and reductionist worldview, and having disregard to more organic worldviews (Orr, 1992, p. 11; 2004). According to Orr, a sustainable society, would be one embedded in a rational, responsible, peaceful, and humane decision-making system that promotes both short-term and long-term benefits, and that would avoid or suppress any initiative that could undermine its own existence (Orr, 2004).

A more recent model, or perspective, of sustainability to be considered is one from Fritjof Capra. According to Capra (2005a), the Brundtland report definition of sustainability does not indicate how a sustainable world can be built and achieved, and therefore, a more operational definition of sustainability is required. Capra (2005b) concludes that understanding the basic concepts of ecology, or "the language of nature" (p. 19), and the characteristics of how successful communities of living organisms have

sustained the process of life for thousands of years, is a critical matter to achieve sustainable communities.

Concerning the basic concepts of ecology, he advises that “the most useful framework to understand ecology today is the theory of living systems, which is still emerging, and whose roots include organismic biology, gestalt psychology, general system theory, and complexity theory (or nonlinear dynamics)” (Capra, 2005b, p. 19). More on this ecological theory of living systems comes later in Section 2.3. For now, the concern is for how Capra’s ideas for an operational definition of sustainability connect with the principles of ecology and living communities through a systems thinking approach.

By taking a systemic approach to sustainability and to the study of the multiple interactions and relationships that occur between the web of communities of living organisms and their environment, core ecological principles and concepts emerge, which in turn, can be used for the design of sustainable communities (Capra, 2005b). In the opinion of Capra (2005b), these principles and concepts may be called ecological principles, principles of community, principles of sustainability, or just plain facts of life. The point is, nonetheless, that all these terms are closely related and point to the idea that a fundamental, sustainable, pattern of organization exists among organic systems (Capra, 2005b).

Following Capra’s discourse, and after “observing hundreds of ecosystems” (Capra, 2005b, p. 22), six fundamental concepts are argued to be at the core of every living community. These concepts are:

1. *Networks*: All members of an ecological community are interconnected in a vast and intricate network of relationships, the web of life.
2. *Nested systems*: Throughout nature we find multi-leveled structures of systems nesting within systems.

3. *Cycles*: The interactions among the members of an ecological community involve the exchange of energy and resources in continual cycles.
4. *Flows*: All organisms are open systems, which means that they need to feed on a continual flow of energy and resources to stay alive.
5. *Development*: The unfolding of life, manifesting as development and learning at the individual level and as evolution at the species level, involves an interplay of creativity and mutual adaptation in which organisms and environment co-evolve.
6. *Dynamic balance*: All ecological cycles act as feedback loops, so that the ecological community regulates and organizes itself, maintaining a state of dynamic balance characterized by continual fluctuations.

(Capra, 2005b)

In relation to an educational perspective towards sustainability, Capra stresses the importance of these ecological principles for EfS when writing "It is no exaggeration to say that the survival of humanity will depend on our ability in the coming decades to understand these principles of ecology and to live accordingly" (Capra, 2005b, p. 29). The understanding of these ecological principles is what is known in the literature as 'ecological literacy' or 'ecoliteracy' (Capra, 2005a, 2005b; Orr, 1992, 2005; Stone & Barlow, 2005). More about this concept comes in Section 2.2.4.

At this point, different definitions, perspectives, models and approaches related to the concept of 'sustainability' have been presented, and in one way or another, all these sustainability 'components' reflect what defines sustainability and how sustainability is perceived in the literature. Based on these different definitions, perspectives and models, arguably five 'key dimensions', or main categories, underpinning the concept of sustainability can be identified. These key dimensions of the sustainability concept are presented in Table 2.1.

Table 2.1. Key dimensions underpinning the concept of sustainability present in the literature.

Sustainability Dimension	**Characteristic / Concept** (*source*)
1. Thinking / Paradigm shift	The idea to change, transform, and/or shift the actual paradigms of thinking that have led to current sustainability issues, to new ways of thinking towards strong sustainability (Cartwright, 2009; Huckle & Sterling, 1999; IUCN/UNEP/WWF, 1991; Lovelock, 2006; Myers & Kent, 2005; Orr, 1992, 2004; Räthzel & Uzzell, 2009; Sterling, 2001; SANZ, 2009; Tilbury & Wortman, 2008; UNESCO, 2006).
2. Systems thinking	The idea to focus on the relations and connections between the different dimensions of sustainability (i.e. environment, social, economic dimensions) (Capra, 2005a, 2008; Corney, 2006; Orr, 2004; PCE, 2002; Räthzel & Uzzell, 2009; Sterling, 2001; WWF, 2005).
3. Ecological literacy	The notion of understanding the underlying ecological principles of living communities, i.e. ecosystems, and live accordingly as a means to 'operate' towards strong sustainability (Capra, 2005b; Orr, 1992, 2004; PCE, 2004; Sterling 2001; WWF, 2005).
4. Future / Long-term thinking	The notion of meeting our own needs without compromising the needs of future generations (Myers & Kent, 2005; Orr, 2004; Walshe, 2008; WCED, 1987).
5. Ethics / Values	The idea to adopt ethical principles and values in accordance with strong sustainability (Dresner, 2008; Orr, 2004; PCE, 2004; SANZ, 2009; Tilbury, 2005).

As mentioned earlier, an attempt to define sustainability is to be made in this section. However, trying to define 'sustainability' is complex (Harris, 2004a; Tilbury, 1995), and arguably, it is not prudent to do so, as it is an evolving concept (Holmberg & Samuelsson, 2006). Nonetheless, the definition of sustainability to be used in this literature review is to be in accordance with the five key dimensions presented in Table 2.1. These five dimensions, which are taken as the 'key ideas' underpinning the

concept of sustainability, are the ones present in the mainstream discourse of the literature. However, it is important to stress that these five key dimensions were identified arbitrarily and are merely a summary of further concepts present in the literature, but that in one way or another, would be related to one of these five key dimensions from Table 2.1.

Moreover, these five key dimensions of sustainability will direct the concept of sustainability in this study. In this sense, 'sustainability' is understood and taken here as *ecological sustainability*. This is a process that aims to modify current practices that have led to social and ecological sustainability issues, to new kinds of practices related to the five key dimensions of sustainability from Table 2.1, and to the idea of promoting a human way of thinking and living that is in harmony with the natural ecosystems' cycles and processes of the planet.

The next section moves on to review the concept of education for sustainability (EfS), which is an educational approach that seeks to address the current sustainability issues as a way to achieve an ecologically sustainable society.

2.2.4 Education for sustainability (EfS)

Education for sustainability (EfS) is one of many terms relating education to the environment and sustainability. Education for sustainability (EfS) is the educational term chosen for use in this research. Nonetheless, and as mentioned before, the terminology debate in the field is ultimately a matter of scope and position (Fien & Tilbury, 2002). Huckle and Sterling (1996) define EfS as an educational process that promotes people's awareness, competence, attitudes and values towards sustainable practices (Huckle & Sterling, 1996). Whereas Fien and Tilbury (2002) note that educational approaches such as EfS must focus on "developing closer links among environmental quality, human equality, human rights and peace and their underlying political threads" (p. 9), stressing the importance of understanding the network of relationships between social, environmental, and other related dimensions.

Other scholars in the field highlight the importance of critical thinking and action competence, as the basis of the 'ecologically literate' person (Eames et al., 2009; Huckle & Sterling, 1996, 1999; Jensen, 2002; Jensen & Schnack, 1997; Sipos, Battisti, & Grimm, 2008; Sterling, 2001). The Parliamentary Commissioner for the Environment of New Zealand recognizes that EfS needs to focus on the underlying relations of the causes of unsustainable practices, and that it should be implemented in a locally and context-based manner (PCE, 2004).

Education for sustainability (EfS) as an educational approach appeared as a new alternative to environmental education (EE) during the late 1980s. Prior to that, EE had begun as a social movement during the late 1960s and early 1970s (Bolstad, 2003b; Gough, 1997; PCE, 2004). At the time, increasing concerns over environmental degradation led to a focus on the role of education as an instrumental means to address the issues related to the natural environment and to development problems (Gough, 1997; Omegna, 2003). During the early 1970s, the essence in the goal of EE was the environment, with less attention to its connection to society, economics and development (McKeown & Hopkins, 2003). In 1980 the World Conservation Strategy (IUCN/UNEP/WWF) first introduced the term 'sustainable development' at the international level, (IUCN/UNEP/WWF, 1980). This was the first manifestation of a reorientation of the goals of environmental education to what is known as education for sustainable development (ESD), to education for sustainability (EfS), and to other similar terms, where the relationships between the environmental, economic and social dimensions are explicit (Tilbury, 1995).

This focus on 'education for sustainable development' (ESD) was later reinforced by the Brundtland Report (World Commission on Environment and Development, 1987), and firmly supported at the United Nations Conference on Environment and Development (Rio de Janeiro, 1992), also known as the Earth Summit, where *Agenda 21* was developed and adopted (Tilbury, 1995). Here, Chapter 36 of *Agenda 21*, 'Promoting Education, Public Awareness and Training', specifically identified four

major thrusts of education and sustainability: improving the quality of and access to basic education, reorienting existing education to address sustainable development, developing public understanding and awareness, and promoting training (UNCED, 1992). In addition, *Agenda 21* highlighted the importance of non-formal education and community-based education, which are the focus of this study.

In December 2002, the United Nations General Assembly launched the 'Decade of Education for Sustainable Development (2005-2014)' (DESD), designating UNESCO as the Decade lead agency (UN, 2002b). The vision of the DESD is "a world where everyone has the opportunity to benefit from education and learn the values, behaviours and lifestyles required for a sustainable future and for positive societal transformation" (UNESCO, 2006, p. 1). The main focuses of the Decade of Education for Sustainable Development are, on the one hand, the bridges that are necessary to be developed between the academic community and the general community needs, and on the other hand, the need for the enactment of sustainability within education in a way that reaches the larger society and biosphere (Sipos et al., 2008).

This historic perspective shed lights on how education, and particularly education for sustainability (EfS), is regarded in the literature as highly significant for addressing socio-ecological sustainability issues. As mentioned earlier, some key learning approaches to EfS are 'critical thinking' and 'action competence'. Critical thinking is regarded as a reflective process that aims to understand, consider and estimate what is the best action or response to pursue while addressing a particular experience, observation and/or argument (Huckle, 1993). In education for sustainability, socially critical education and socially critical skills, or "the art of critical thinking" (Orr, 2004, p. xii), are seen as essentials to effectively achieve the realization of sustainable living (Hofreiter, Monroe, & Stein, 2007; Huckle, 1991; Huckle & Sterling, 1996; Nicolaou et al., 2009; Tilbury, 1995). Critical thinking in EfS aims to promote the ability to evaluate complex arguments, analyze the symptoms and root causes of

environmental and sustainability problems, and to “create a citizenry that can use information to solve problems and make responsible decisions” (Hofreiter et al., 2007, p. 149).

As for action competence, the ‘action’ component in EE and EfS is regarded as what will lead towards a real improvement of the environment, and thus is crucial for achieving ecological sustainability (Bolstad, 2003b). In this sense, Jensen and Schnack (1997) introduced the concept of ‘action competence’, highlighting that any action undertaken (i.e. action for the environment and/or towards strong sustainability) must be done consciously, and thus, needs to be considered and targeted. This can be better expressed in terms of the intentionality of an action, in contrast with an activity, where addressing the causes of a problem is not a requirement (Jensen & Schnack, 1997). This implies that individuals must understand why and for what purpose they are undertaking a particular action (Jensen, 2002; Palmer, 1995). Jensen (2002) argues that there are four dimensions of knowledge associated with environmental issues that eventually would lead to an action. These dimensions are: effects, root causes, strategies for change, and visions (Jensen, 2002). In relation to these four aspects of action competence, Eames, Law, Barker and Mardon (2009) proposed a series of learning requirements that contribute to the development of action competence in EfS. These are:

- Experience
- Reflection
- Knowledge (understanding)
- Vision for a sustainable future
- Action
- Connectedness (linking attitudes, values, and behaviour)

(Eames et al., 2009)

Moreover, because EfS educators have recognised that raising awareness about environmental issues is not sufficient to address sustainability challenges existing today (Tilbury & Wortman, 2008), action competence as a learning approach is recommended within the literature as a key

component of EfS, in order to achieve transformative change towards ecological sustainability (Fien & Tilbury, 2002; Sterling, 2001). Finally, Räthzel and Uzzell (2009) state that "the value of action competence is that environmental issues can be conceived within a broader environmental, social and political context of causes and consequences", and encourage people to adopt a critical perspective of the relationships between these different environmental and social contexts (Räthzel & Uzzell, 2009, p. 273).

In another perspective, Sterling (2001) proposes that as a key to strong sustainability, there is a need to change from transmissive to transformative learning approaches, which involves a whole educational paradigm change at all levels and on the part of all people concerned with achieving healthy societies and sustainable ways of life. The principal argument underlying Sterling's position is that within the last two decades, "education has been re-structured and repackaged to conform to the philosophy and perceived needs of the market, and the managerial influence may now be seen in most Western and Westernized education systems across the world" (Sterling, 2001, p. 12), creating top-down and centre to periphery views of education, and reinforcing unsustainable values and practices (Sterling, 1996, 2001). This last represents an evident dilemma for sustainability and for EfS, as existing educational systems support the reproduction of social practices and ideologies that are, arguably, at the origin of environmental and sustainability problems (PCE, 2004; Sipos et al., 2008). Regarding the characteristics of a transformative educational paradigm to achieve strong sustainability, Sterling states that "examinations of descriptions of what the desired 'new way of thinking' might be reveals much use of terms like integrative, holistic, systemic, connective, and ecological" (Sterling, 2001, p. 23).

Concerning other important components of EfS present in the literature, and as mentioned earlier in Section 2.2.2, under the assumption that an individual's values and beliefs are consistently reflected in her/his behaviour, sustainability issues are regarded by some scholars as

including a problem of attitudes and values towards the natural environment. Different calls point to the need for EfS to educate not only about practical and action-oriented skills, but also about principles, values, and attitudes (Arcury, 1990; Eames et al., 2006; Gayford, 1987; Jensen, 2002; Tilbury, 1995). Here, the emphasis is on ethical principles and values that are in concordance with strong sustainability postulates (Stone & Barlow, 2005; SANZ, 2009). Integration of values requires from learners that they understand environmental and sustainability consequences of their own value stance and point of view (Tilbury, 1995).

In addition, as sustainability issues are so influenced at the political level, it follows that EfS should include the ability to participate in civic and democratic processes, or what might be called 'political literacy'. Political literacy is seen as the ability to understand and participate in the resolution of environmental and sustainability problems at a societal level (Tilbury, 1995). Political literacy empowers individuals with democratic skills and values for participation and action, considered key components of any educational approach that aims towards sustainable living (Capra, 2005a; Gough, 1997; UNCED, 1992; UNESCO, 2006). Participation, in this context, is seen as the link between education and democracy, because a democracy without educated citizens is like an ''empty shell"; and, "education with no democratic dimension is little more than training or a tool for indoctrination" (Schnack, 2008, p. 191). In other words, as stated by the Parliamentary Commissioner for the Environment of New Zealand, "public participation is vital for democracy and sustainability" (PCE, 2004, p. 44). Myers and Kent (2005) stress that changes towards sustainability must come from the civil society, from the power of community through democratic processes, in order to generate governments' policy changes as a result.

As mentioned earlier, another important concept underlying EfS is ecological literacy, sometimes also called ecoliteracy and/or environmental literacy. This concept is one of the five dimensions identified from the literature underpinning the concept of sustainability in Section 2.2.3.

Ecological literacy, rather than being a teaching and learning educational approach needed for EfS, is more related to the process of 'understanding' the underlying ecological principles of living communities, and to 'live accordingly' (Capra, 2005b). Therefore, different EfS teaching and learning approaches (e.g. critical thinking) could potentially promote ecological literacy.

According to David Orr (1992), ecological literacy "implies a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably" (p. 92). Ecological literacy has a strong philosophical basis in the concept of systems thinking, under the assumption that "*communities of organisms*, including both ecosystems and human social systems such as families, schools, and other human communities, are living systems" (Capra, 2005b, p. 19). Ecological literacy scholars argue that to be a literate person in a sustainable-living society, a comprehension of whole-system knowledge, or to understand how things are connected and interrelated, is an essential skill to learn (Armstrong, 2005; Barlow & Stone, 2005; Capra, 2005b; Orr, 2004; Sterling, 2001). Moreover, the 'practical competence' dimension, or the ability to act towards sustainable living, is also highlighted as part of the skills of an ecologically literate person (Orr, 1992, 2004).

The concepts and educational approaches mentioned in this section are key components of EfS present in the literature. In this sense, EfS is regarded in the literature as an effective means to address socio-ecological sustainability issues, by means of improving both people's understanding and action towards the environment and to sustainability (Gough, 1997; Huckle & Sterling, 1996; PCE, 2004; UNEP, 1992; UNESCO, 2006). It is in this sense that education, and particularly education for sustainability, is taken here: as a significant and valid 'instrument' to address the environmental and sustainability issues and challenges. Concerning the key components underpinning EfS from this section, Table 2.2 summarises the different approaches and 'EfS

components' present in the literature, and relates these with the key components of sustainability identified earlier in Section 2.2.3 (see Table 2.1).

Table 2.2. Summary of key EfS components present in the literature, and their relation to sustainability components from Table 2.1.

Sustainability Components	**EfS Components / (*Source*)**	
1. Thinking / Paradigm shift	1. Transformative education (e.g. critical thinking)	(Huckle, 1993; Huckle & Sterling, 1996, 1999; Sterling, 2001)
2. Systems thinking	2. Systems thinking	(Fien & Tilbury, 2002; PCE, 2004; Sterling, 2001, 2005; Stone & Barlow, 2005)
3. Ecological literacy & **4. Future / Long-term thinking**	3. Ecological literacy	(Capra, 2005b; Orr, 1992, 2004; Sterling, 2001)
	4. Action competence	(Eames et al. 2009; Jensen, 2002; Jensen & Schnack, 1997; Sipos et al, 2008)
	5. Political literacy and social democracy skills	(Gough, 1997; Myers & Kent, 2005; PCE, 2004; Tilbury, 1995)
5. Ethics / Values	6. Principles, attitudes and values	(Arcury, 1990; Eames et al., 2006; Jensen, 2002; SANZ, 2009; Stone & Barlow, 2005)

As mentioned above, within the EfS components presented in Table 2.2, two underlying and interconnected concepts arise: *understanding* of sustainability issues, and *action* for sustainability or sustainable living. Understanding of sustainability issues is referred to as awareness and comprehension of the (root) causes of sustainability problems (i.e. cognitive dimension of sustainability) (Sipos et al., 2008). Whereas, action for sustainability, or 'towards' sustainability, involves taking practical and targeted action that will impact on sustainability, for which a prior understanding of the sustainability context is required. This is what Sipos

et al. call the 'psychomotor dimension' of sustainability (Sipos et al., 2008). It is argued in the literature that EfS should promote both understanding of, and action for, sustainability (Huckle & Sterling, 1996, 1999; Orr, 1992, 2004; Sipos et al., 2008; Sterling, 2001; WWF, 2005).

In another reading, 'systems thinking', 'principles, attitudes and values', and 'ecological literacy' are also components identified in Section 2.2.3 as underlying the concept of sustainability (see Table 2.1 for details), which highlights the importance of these components and their underlying theoretical backgrounds for strong sustainability. These ideas and the key components of EfS from Table 2.2 are further discussed throughout this literature review.

2.2.5 Summary

The key points from this section are that the concept of sustainability is complex, demands urgent attention, and involves a variety of underlying principles, dimensions and concepts. 'Sustainability' is also subjected to different views from different fields of endeavour. Common points between dissimilar concepts of sustainability, and key components of EfS present in the literature, are: systems thinking, ecological literacy, 'principles and values' towards strong sustainability, and the 'action' dimension. These common points are related to both *understanding* sustainability issues (i.e. cognitive dimension of sustainability), and *action* towards a more sustainable society (i.e. psychomotor dimension of EfS) (Capra, 2005b; Orr, 2004; Sipos et al., 2008).

Another important issue within the literature is that in order to achieve sustainable living and sustainable communities, the need for a change, or transformation, of the current paradigms and practices that have led to socio-ecological sustainability issues is essential. In this sense, education for sustainability (EfS) is regarded in the literature as significant and indispensable for addressing socio-ecological sustainability issues, and for the achievement of sustainable societies. Moreover, emphasis on understanding the relations between all the issues and dimensions

involved in sustainability is common within EfS literature. This is what is called ‘systems thinking’. In the context of this study, systems thinking is taken as an underlying approach to ecological literacy and to ecological sustainability. The next section of this literature review deals with the definition and principles of systems thinking, and with the relation between systems thinking and EfS.

2.3 Systems thinking and education for sustainability

This section introduces and reviews some key aspects of systems thinking, and other related theories and approaches associated to this concept. It has been suggested in the literature that new complexities and interdependences in today’s modern world require a change in perception and thinking. As argued by some scholars, traditional non-whole thinking approaches, such as mechanistic reductionism, are at the basis of current socio-ecological sustainability issues (Capra, 1994; Orr, 1992; Sterling, 2001). A systemic, holistic, and whole-thinking perspective towards sustainability, with emphasis on the quality of the relationships existing between different dimensions of sustainability, may be a more effective approach to address the complexity and unpredictability of socio-ecological issues and challenges.

The adoption of systems thinking in EfS is widely supported in the literature. In the context of this study, systems thinking is regarded as a useful approach, not only for addressing sustainability issues and the provision of EfS, but also for the evaluation of the impacts of the implementation of ICT-based educational programmes (Huckle & Sterling, 1996; Somekh, 2007; Sterling, 2001, 2005; Vrasidas et al., 2007; WWF, 2005). In this sense, the aim of this section is to review how the concept of systems thinking can be a useful approach for addressing socio-ecological sustainability issues, and for the development of an ICT and EfS theoretical framework for community education.

This section is divided into two parts. The first part reviews some basic principles related to systems theory and systems thinking, with particular

emphasis on sustainability. In the second part, some key ideas concerning the integration of systems thinking with education for sustainability are presented and explored.

2.3.1 Systems theory and systems thinking

Systems theory is an interdisciplinary field of study that focuses its attention on the relationships existing within the components of a 'system'. In this sense, a system is regarded as a whole composed of interconnected parts, where the interactions of the parts determine the qualities or 'properties' of the system (Ison, 2008; Morris & Martin, 2009). Such properties of the system "cannot be reduced to those of smaller parts" (Capra, 2008, p. 2). Some examples of systems are: a city, a nation, a computer, an economy, a person, a family, an animal, a tree, a forest, a regional ecosystem, a solar system (WWF, 2005). In addition, different systems have different purposes (functions), and can be studied from a variety of perspectives (Aracil, 1995).

The origin of systems theory, which has been the basis for many 'systemic' and integrative disciplines and approaches (e.g. such as systems thinking and complexity theory), goes back to the 1920s and '30s. At the time, dialogue between biologists, ecologists, and psychologists derived the notion that systemic properties could only be found as part of the 'whole', hence the systemic phrase 'the whole is more than the sum of its parts' (Capra, 2008). It has been reported that the systemic worldview historically appeared as an alternative to the mechanist and reductionist philosophies, whose fundaments reside in Cartesian logic (i.e. coined from the French philosopher René Descartes (1596-1650)) of the 17th century, which has arguably been the foundation of the modern Western philosophical and scientific worldviews (Orr, 2004; Sterling, 2001; Worster, 1989).

It has been suggested that analytical and reductionist thinking (i.e. the type of thinking that focuses on understanding things by taking them apart) is dominant in the Western tradition, and arguably the principal cause of

today's socio-ecological sustainability issues (Capra, 2008; Huckle & Sterling, 1996; Lovelock, 2006; Orr, 2004; Sterling, 2005; SANZ, 2009; WWF, 2005). Furthermore, it is argued that, although the analytical and reductionist worldviews may have worked in the past, today they are no longer appropriate approaches (WWF, 2005). This is because the problems of the increasingly complex, interdependent and globalised modern world cannot be understood in isolation or by taking them apart. Rather, as these are systemic problems, a radical shift in perception, thinking, and values is required (Brown, 2008). This involves the need for a new paradigm, where thinking in terms of relationships, or adopting a systems thinking worldview, is necessary at all levels (Orr, 2004; Sterling, 2001).

In this context, a system is defined as a group of components that have a specific relationship to each other, and thus are interrelated in a network of flows of matter, energy, and/or information (Aracil, 1995; WWF, 2005). These components might be further constituted by sub-components and/or sub-systems, and in turn can be part of supra-components and/or supra-systems. From an educational perspective, Sterling (2005) defines a system as, "put simply, a system is a set – or pattern – of relationships. Beyond this description, we can say it consists of three kinds of things: elements (things), interconnections (processes) and purpose (function)" (Sterling, 2005, p. 19).

A key feature of systems is that their properties are the result of the whole and cannot be found in their parts. This is known as *emergence* (i.e. also 'emergent properties') of a system (Center for Ecoliteracy [CEL], 2009b; Corning, 2002). Goldstein (1999) defines emergence as "the arising of novel and coherent structures, patterns, and properties during the process of self-organization in complex systems" (Goldstein, 1999, p. 49), whereas Sterling regards 'emergent properties' as "qualities that cannot be predicted from looking at the parts alone" (Sterling, 2005, p. 19). Other properties of systems are that they possess boundaries and are immersed within a particular context (or environment), they are not static but rather

are dynamic (i.e. in constant change and adaptation to the changes in its environment), and, when looking at a universe of systems, patterns of interactions tend to appear between them (Aracil, 1995; WWF, 2005).

It is proposed that the best way to study a system is through a model, which is a theoretical representation of a system. In relation to this, it is argued that any phenomenon can be regarded in a systemic manner, and therefore represented by a model (Aracil, 1995). A system's model ideally has to include all the known categories of components and their specific network of relationships (i.e. inputs, outputs, loops, positive and negative feedbacks, etc.). However, it is important to note here that modelling, or the process of interpreting and representing systems through a model, is subjected to the personal interpretation of the interpreter, and thus, is a subjective and qualitative process (Sterling, 2001, 2005). From a constructivist view (i.e. theory of personal constructs), all models can be equally valid, and depend largely on personal perceptions and interpretations of a shared reality (Aracil, 1995; Kelly, 1991; Sterling, 2005). Capra points out that "mapping relationships and studying patterns is not a quantitative but a qualitative approach", highlighting the importance of qualitative perspectives for systems thinking (Capra, 2008, p. 2).

The systems theory has been a fundamental source for the development of other related theories and approaches that regard interrelatedness of things as its central focus. The review of some of such theories might permit a further understanding of systems thinking, and how systems thinking might be a useful approach to address sustainability issues. An example of such a theory, in the realm of natural sciences, is the *Gaia theory*, named after the Greek Goddess of Earth (Ogle, 2006). The Gaia theory assumes that the planet Earth as a whole is a self-regulating system where organic and inorganic matters have evolved together as a single living organism (Lovelock, 2006). The British scientist James Lovelock developed the Gaia hypothesis (now known as the Gaia theory) during the 1970s. At that time, different research and work done on self-

organizing systems and emergent properties contributed to the development of the Gaia theory (Orrell, 1998).

This was also the time when Chilean neuroscientists Maturana and Varela were developing their autopoietic (i.e. literally 'self-making') definition of life, which principally states that living organisms produce, by their own rules, the components and boundaries that specify them as a concrete unit in space and time (Maturana & Varela, 1980, 1987; Varela, Maturana, & Uribe, 1974). For many scientists, *autopoiesis* offers a "more accurate definition of what is life, because it doesn't focus on the components (i.e. CHONPS, the most common elements in living organisms) but rather on the structural processes" (Rytz, 2007, p. 3), therefore regarding life as an emergent property of a system that has its own set of regulatory mechanisms. The autopoietic definition of life, and other systemic evidence compiled during the 1970s and 1980s, further contributed to the development of the Gaia theory, which gained important support from some sectors of the scientific community, and has today some impact on modern science and philosophy (Thompson, 1987; Lovelock, 2006; Ogle, 2006, 2008; Rytz, 2007).

In relation to ecological sustainability, understanding the Gaia and the autopoiesis theories and their relationships permits better insights into the ecological principles of nature, and how the process of life has been sustained for millions of years. It has been claimed that to understand these ecological principles is crucial for ecological literacy, for sustainability and for EfS (Capra, 2005b, 2008; CEL, 2009a; Orr, 2004; Sterling, 2005). As an example, particularly regarding climate change, it is argued that most of the human-made materials released into the environment are *allopoietic* (i.e. non-autopoietic) which means that the processes that created these materials are separated from the unity that maintains life on Earth, and thus, do affect the natural dynamic balance of life on Earth, contributing to socio-ecological sustainability issues (Lovelock, 2006; Maturana & Varela, 1987; Rytz, 2007).

The various aspects mentioned in this section are what principally constitute 'systems theory', where the focus of attention is on the existing set of relations amongst the different components of a system (Aracil, 1995). The use of systems theory, or the adoption of a systems thinking perspective, may be a useful approach for understanding complex and unpredictable systems related to ecological sustainability, and to the use of ICT for community EfS (Huckle & Sterling, 1996; Orr, 2004; PCE, 2002; Somekh, 2007; Sterling, 2001; Vrasidas et al., 2007; WWF, 2005). The next section discusses this further.

2.3.2 Systems thinking and education for sustainability

This subsection addresses the use of systems thinking approaches in education for sustainability in two parts. The first part reviews the application of systems thinking and complexity theory principles in educational settings. The second part examines educational and pedagogical considerations from systems thinking that can be of assistance to EfS.

2.3.2.1 Application of systems thinking in educational settings

Literature from systems thinking, and other related theories such as complexity theory in education (i.e. where the focus of study is learning adaptive systems), highlights a series of principles and theoretical considerations recommended for educational settings. For example, while approaching education and social learning from complexity theory and chaos theory, Jorg (2000) states that "wanting a different description of social learning, as an active constructive process of dynamic complexity, one had better describe it in terms of reciprocal influences by reciprocal adjustments between interacting actors" (Jorg, 2000, p. 1).

In this sense, Jorg (2000) introduces the idea of 'reciprocal relationships' in learning, and regards learning itself as an *emergence* between the coupling that occurs between learning actors (Jorg, 2000). According to Sumara and Davis (1997), this idea of coupling "suggests that a new transcendent unity arises when two or more persons come together in

conversation or in any shared action" (Sumara & Davis, 1997, p. 414). From a systemic perspective, this points to the idea that a learning process might occur when two 'learning actors' interact. In relation to the present study, this learning interaction could occur when a community member uses an EfS website (i.e. both considered as learning actors), with learning occurring as an emergence of this 'coupling' process.

Sumara and Davis (1997) further argue that "the cultural practice known as 'education' occurs within and among complex systems that span several phenomenal levels", and thus, "educational theories and practices that are inattentive to the particularities of context and, more specifically, that are inattentive to the evolving *relations* among these particularities, are no longer adequate" (p. 418). This highlights the importance of the learning context for EfS, as different contexts (i.e. the environment of the learning system) affect the outcomes of the relations occurring amongst the components (i.e. learning actors) of the learning system (Aracil, 1995; Sterling, 2005; Sumara & Davis, 1997). This is particularly important in regard to the socio-cultural contexts of EfS (Cole & Engeström, 2001; Hofstede, 2001). The cultural context issue is further explored in Sections 2.4 and 2.5, so for the moment key systems thinking ideas for educational settings are the importance of the coupling process between learning actors where learning occurs as an *emergence* from such interaction, and that learning process is influenced by its learning context.

Pursuing the idea that the particular structure and context of a system determines the outcomes of its function (purpose), Murray (1994) highlights some implications for education in stating "we cannot directly 'cause' people to learn. We cannot pour in information. But we can try to create conditions in which students can make connections with their own personal histories (their structure)" (p. 7). Furthermore, Murray argues that knowledge is about 'doing interpersonal relationships', and that educational settings (i.e. referring particularly to school settings) should focus on "creating the context in which school learning can best occur" (Murray, 1994, p. 13). This idea expressed by Murray (1994) of 'creating

contexts where learning can best occur' can be extended to non-formal educational settings, and in the particular case of this study, to the use of community EfS websites.

Related to the above, Davis and Sumara (2005) report that complexitivists have gone from trying to understand the emergence and self-regulated characters of systems, to an increased emphasis on "the deliberate creation and nurturing of complex systems" (Davis & Sumara, 2005, p. 457). In terms of the domain of education, Davis and Sumara (2005) comment that complexity theory aims to understand how complex learning systems can cohere and unfold into an educational system, and how such an educational system can be created and nurtured to facilitate the learning process. These authors highlight the following key conditions for the creation and nurture of educational systems: interactivity, diversity, means for learners to affect each other, and a decentralized control structure (Davis & Sumara, 2005). These key conditions highlighted by Davis and Sumara (2005) may be of assistance to inform the design and development of community EfS websites. Similarly, the importance of understanding the creation and nurturing process of complex systems for ecological sustainability is that this could contribute to better achieve sustainability goals by means of more effective sustainable practices (Capra, 2008).

In relation to the characteristics that such types of educational setting should encompass for the provision of community EfS through the use of ICT websites, some important ideas can be adapted from Morrison (2002), who highlights key aspects of complexity theory in educational settings related to school leadership. Morrison (2002) states that, in the context of school management, leadership is critical to enable and empower learners through education. In such contexts, leadership implies being a "facilitator of information exchange rather than its gatekeeper", and that "the leader is simply the one who goes first and shows the way", not necessarilly directing but enabling (Morrison, 2002, p. 19). This idea of being an *educational leader* and an *educational facilitator* can be applied to an EfS

website: the EfS website as a learning actor can be the one actively seeking the coupling with another learning actor (i.e. community member), by facilitating such a process, and enabling and empowering community members towards socio-ecological sustainability. In short, an EfS website could be regarded, and act, as an educational facilitator at the community level.

The approaches reviewed in this subsection are key ideas and considerations from systems thinking, as well as from complexity theory in education, which may be of assistance in the development of a theoretical framework to inform the development of EfS websites at the community level. The next section reviews educational and pedagogical perspectives from systems thinking literature that may contribute to the theoretical considerations for the development of EfS websites.

2.3.2.2 Systems thinking educational perspectives for EfS

This subsection focuses on some systems thinking-related concepts that are recommended learning requirements for EfS. For example, some authors report a growing support in the literature for the application of complexity theory, not only in education, but also in a broad range of disciplines (Morris & Martin, 2009; Stone & Barlow, 2005; Strachan, 2009). Nonetheless, the social adoption of systems thinking concepts appears to be difficult mainly because, as mentioned before, the mechanistic tradition based on analytical and reductionist thinking prevails in Western societies (Orr, 2004; Sterling, 2005). However, we live in a world characterised by non-linear systems, and ruled by complex and unpredictable dynamics (CEL, 2009b; Orr, 2004; Sterling, 2005; Sumara & Davis, 1997).

In such complexity, Sterling (2001) states that the key to achieving a more sustainable world is learning. Capra (2008) argues that in the coming decades “the survival of humanity will depend on our ecological literacy”, which “should be the most important part of education at all levels” (p. 1). However, during the last two decades “education has been re-structured and repackaged to conform to the philosophy and perceived needs of the

market, and the managerial influence may now be seen in most Western and Westernized education systems across the world" (Sterling, 2001, p. 12). Sterling further argues that such educational systems only lead to more sustainability issues and challenges, and therefore, there is a need for a new educational paradigm based on transformative learning and systems thinking (Sterling, 2001, 2005). According to the Center for Ecoliteracy (CEL) (2009), it becomes evident that to think in terms of systems thinking, a shift in perception is needed:

- From parts to the whole
- From objects to relationships
- From objective knowledge to contextual knowledge
- From quantity to quality
- From structure to process
- From contents to patterns

(Center for Ecoliteracy, 2009b)

It has been suggested in the literature that learning to think holistically, or to adopt a systems thinking approach, is critical to education for sustainability (EfS) (CEL, 2009b; Huckle & Sterling, 1996; Nicolaou et al., 2009; PCE, 2002, 2004; Sterling, 2001; Tilbury & Wortman, 2008). From an EfS point of view, this means to educate people in how to look at sustainability issues as systems, patterns, connections, and root causes (Orr, 2004; Sterling, 2001). In a series of systems thinking educational perspectives for sustainability, WWF (2005) proposed a framework including the following key educational concepts for EfS:

- Sensibility (awareness)
- Theory (understanding)
- Practice (action competence)
- Relevance and real-world issues
- Affective and hands-on learning
- Critical thinking and systems thinking

(WWF, 2005)

In this study awareness is considered as included within the notion of understanding, as to understand something, arguably, one first should be aware of that 'something' to be able to consequently understand it. The understanding component relates to descriptive aspects of sustainability issues based on known concepts and theory, and the action competence concept relates to more practical dimensions (WWF, 2005).

Concerning the other components of the above list, besides 'relevance and real-world issues', all the others have already been mentioned and discussed in Section 2.2.4 as underpinning EfS. In terms of the 'relevance and real-world issues' point, historically this component has been an integrative part of EE and EfS, principally because EE and EfS seek "to interest and involve students in real-world problems" (Tilbury, 1995, p. 199). More on this concept follows as part of Sections 2.4 and 2.5, dealing with 'EfS through ICT', and 'EfS using ICT in the community', respectively. Overall, systems thinking ideas in EfS, as well as other associated educational perspectives such as critical thinking and action competence, seek to develop the ability to analyze and evaluate symptoms, root causes and connections of complex sustainability issues on learners.

As a summary of this subsection, several key components and ideas of systems theory and systems thinking have been described and appear to be useful approaches for the provision of EfS. These key ideas were separated under two categories of systems thinking concepts for EfS: (1) application of systems thinking concepts in educational settings; and (2) systems thinking educational perspectives for EfS. The first category includes systems thinking principles and approaches recommended in the literature, whether for formal or non-formal educational settings. These include consideration of the learning context, interaction between learning actors, the creation and nurturing of educational systems, and the issue of regarding educational systems as facilitators of learning (Davis & Sumara, 2005; Jorg, 2000; Morrison, 2002; Sterling, 2005). The second category of systems thinking related ideas concern perspectives of systems thinking for EfS, such as, for example, promoting systems thinking, critical thinking,

and/or development of the affective dimension in learning. These two categories of systems thinking concepts are summarised in Table 2.3.

Table 2.3. Systems thinking concepts and ideas related to education for sustainability.

I. Systems thinking application in educational settings	
1. Learning context	Concept of the importance of the learning environment for the promotion of meaningful experiences for learners (Murray, 1994; Sterling, 2005; Sumara & Davis, 1997).
2. Coupling and Interaction	Concept of 'coupling' and interaction between learning actors with 'learning' occurring as an emergent property (Jorg, 2000; Sumara & Davis, 1997).
3. Creation and Nurture	Concept of promoting the creation and nurturing of educational systems as a way to facilitate the learning process (Davis & Sumara, 2005; Murray, 1994).
4. Leadership / facilitator	Educational systems regarded as *leaders* and *facilitators* that enable learning and empower learners (Morrison, 2002).
II. Systems thinking educational perspectives for EfS	
1. Systems thinking	Education about systems, connections and patterns of sustainability issues (CEL, 2009; Orr, 2004; Sterling, 2001; WWF, 2005).
2. Critical thinking	Education towards the ability to analyze and evaluate symptoms, root causes and connections of sustainability issues (Orr, 2004; Sterling 2001).
3. Sensibility	Development of affective dimension through relevance and real-life issues to promote awareness and meaningfulness (Sumara & Davis, 1997; Tilbury, 1995; WWF, 2005).
4. Theory	Education of concepts, knowledge and theory about sustainability issues (Sterling, 2005; WWF, 2005).
5. Practice	Education of hands-on, practice and action skills to address sustainability issues (Sterling, 2005; WWF, 2005).

2.3.3 Summary

From the literature reviewed in this section, it is important to highlight that systems thinking is about addressing the relationships existing between the components of any system. In the case of the present study, the system being addressed is an educational system, underpinned by an EfS website, and aimed at promoting socio-ecological sustainability at the community level. To adopt a systems thinking approach in this context means to focus on the relationships and emergent properties existing from the interaction of the components of such a system, rather than on the structure of the individual components. Moreover, according to the literature, such educational systems can only be created and maintained (i.e. nurtured), if some key conditions are present. These types of systems could in turn facilitate the learning process for community members. In this context, the literature also advocates for some educational approaches that can promote systems thinking skills amongst community members.

Having reviewed different aspects related to systems thinking in education for sustainability, the following section addresses how the provision of EfS can be achieved through the use of ICT-based technology.

2.4 Education for sustainability through Information and Communication Technology

This section introduces key issues of Information and Communication Technology (ICT) in the context of sustainability and education for sustainability (EfS). In short, the term ICT refers to the use of technology for the management and communication of information. This term is widely used and can involve different things depending on the field of knowledge, as well as it can be regarded from a variety of perspectives and positions. It is consequently important to acknowledge that the use of ICT encompasses a great variety of approaches, concepts, situations and contexts. In the context of the present study, the use of ICT is regarded as a communication and educational tool for EfS, and particularly, ICT features such as Internet websites are considered in terms of their ability to promote learning around EfS. In this sense, the use of ICT with the

Internet has been shown to enhance the access to information for the general public (Kling, 2000), and has potential for improving EfS teaching and learning practices (Nicolaou et al., 2009; Nomura, 2004; Phelps et al., 2008; Wallace, 2004).

The present 'EfS through ICT' section is organized in three parts. The first part presents general aspects and concepts related to ICT, the Internet, and websites. The second part introduces some characteristics and key issues regarding the use of ICT and Internet websites in education, with a mention at the end of the section of the potential of the use of EfS websites for community education. Finally, the third part reviews some key aspects of the website design process, with a focus on design considerations related to EfS websites. The purpose of this section on EfS through ICT is to identify key ideas from the literature to inform the theoretical model for the development of EfS websites for community education.

2.4.1 General aspects of Information and Communication Technology (ICT)

Information and Communication Technology, or 'ICT', is a widely used term. According to Haddon (2004), the term 'ICT' stems back to the mid-1980s, and encompasses any kind of technology used by individuals and organizations to manage information and/or to communicate (i.e. broadcasting, telecommunications, computer-mediated communication, etc.). In this sense, ICT is regarded as "both service and product" developed to assist with the organization and flow of information (Kompf, 2005, p. 220). Information and Communication Technology is today widely used across all areas of knowledge and activity, facilitating information management and communication of information (Aivazidis et al., 2006; Somekh, 2007; Vrasidas et al., 2007). In this context, the most common and popular ICT technologies and tools used for information communication are: radio, TV, communication technologies (e.g. antennas, radars, satellites), computers, the Internet, and mobile and wireless technology (Becta, 2008, 2009; ITU, 2013; Sanger, 2001).

In relation to the present study, the ICT tools being considered here are principally computers, the Internet and websites. These types of tools can be differentiated into two categories: hardware and software. As defined by the *Hutchinson Encyclopedia of Science* (Helicon, 2006), hardware is the "mechanical, electrical, and electronic components of a computer system" (p. 154), whereas software is defined as "a collection of programs and procedures for making a computer perform a specific task" (p. 949).

Concerning the Internet, it is a network of interconnected computers using a common transmission language (i.e. TCP/IP) (Jacobson, Mcduff & Monroe, 2006). The most common system that accesses the Internet is called the World Wide Web or just the Web, a global and public interconnected network that uses common communication protocols to transmit information and data from one computer to another, principally in the form of Web sites (also called websites) (Anderson, 2006; Jacobson et al., 2006). In the words of Owston (1997), "the World Wide Web is a unique way of linking text, images, sound, and video resources on computers connected to the Internet" (p. 33). The impact of the development and implementation of the Internet has been enormous: "in 2002, Internet-related activities accounted for nearly 10 million jobs. By 2006, it was estimated that there were more than 1 billion Internet users worldwide" (Helicon, 2006, p. 259). More recent figures indicate that by the year 2009, 25% of the world's population had access to the Internet, and in 2013 it is estimated that this percentage increased to almost 40% of the world's population (International Telecommunication Union, 2013). Moreover, the development of new technology, hardware and software, as well as the penetration of Internet connectivity are in constant increase (Clark, Logan, Luckin, Mee, & Oliver, 2009; ITU, 2013; Somekh, 2007).

The World Wide Web is composed of many different websites. Every website has a unique Internet address that identifies it, called Uniform Resource Locators (URLs), which are in the form of 'http://…' (e.g. http://www.waikato.ac.nz) (Owston, 1997). Owston (1997) defines a website as information formatted in forms of "pages" (p. 33). Thus, a

website may consist of one or many integrated pages with information on it. Websites may have different types of information, i.e. text, images, sound, video, as well as multimedia representations of information (Jacobson et al., 2006; Owston, 1997). Websites can passively present information, like simple text or pictures, or include more *dynamic* types of information, such as videos or animations, or even offer virtual tours to distant places, where a combination of types of information result in such experience (Becta, 2008; Jacobson et al., 2006).

2.4.1.1 The concept of affordance in ICT

At this point the concept of 'affordance' needs to be introduced. In the context of ecology, Gibson (1979) coined the term *affordance* in reference to what a particular environment has to offer to an organism. In Gibson's words, "affordance implies the complementarity of the animal and the environment" (Gibson, 1979, p. 127). In the field of ICT, the term affordance is used in the context of the possibilities that technology can offer to users (Wallace, 2004). An affordance not only depends on what technology can offer to users, but also on the possible actions that users can carry out with such technology (Webb, 2005). Therefore, the affordance exists in the domain of the interaction between ICT and users.

Woo (2009) states that the opportunities offered to users through technology do not necessarily imply that it will result in an action by the user, and thus, "it is the user, not the technology per se, who determines if the technology is useful" (p. 214). This calls for great emphasis on the understanding of users' characteristics and needs in order to design meaningful ICT-based affordances (Dohn, 2009; Webb, 2005; Woo, 2009). Hence, the affordances provided by ICT, the Internet and websites are varied, and depend greatly on the ways, and purposes for which, the affordances of such technologies were designed, on the needs and characteristics of users (e.g. ICT skills and knowledge), and on the particular type of interaction with users (i.e. including the context of interactions) (Wallace, 2004; Woo, 2009).

It is evident from this discussion that ICT involves many different perspectives and potential types of use. In the context of the present study, the focus of the use of ICT relates to its potential to assist community education related to socio-ecological sustainability. From an EfS perspective, an ICT-based educational process should be aimed at promoting both understanding of sustainability issues and action towards sustainable living. With this in mind, the next section reviews some key issues and concepts present in the literature related to the use of ICT in education.

2.4.2 Use of Information and Communication Technology in education

The use of ICT has had a great impact on education. In many countries, the use of ICT and the Internet in education are considered as tools to promote access to learning opportunities. This is argued in that ICT and online education (i.e. education through the Internet) is less linked to time and location restriction, and can be more flexible and amenable to learners' needs (Pont & Sweet, 2006). According to Becta (2009), a technology-focused educational organization, "more and more learners of all ages are using technology for learning" (p. 18). This has placed ICT in a prominent position, resulting in calls from international organizations and documents for training, implementation and use of ICT in educational systems and environments (Kompf, 2005; OECD, 2006; UNESCO, 2003; Vrasidas et al., 2007). At least three aspects of the use of ICT in education can be identified: ICT as a subject, as a tool for learning (e.g. use of word processors and/or simulations), and learning through ICT, "where the ICT facility becomes the whole learning environment by providing learning materials and acting as assessor and tutor" (Webb, 2002, p. 238).

Nonetheless, there are also many obstacles and barriers to the use of ICT in education. These principally include access to and availability of ICT infrastructure and Internet connectivity, ICT literacy and skills from users, and lack of motivation and incentive from users for the use of ICT and the Internet for learning purposes (OECD, 2006; Pont & Sweet, 2006). In

addition, there has been some debate in the literature regarding the real effectiveness of ICT for the provision of education. For example, there is concern with the mismatch between the use of ICT in the formal secondary context for educational purposes, and its use at home by young learners for entertainment, principally because, it is argued, this represents a lost potential for ICT to transform schooling (Donoso & Roe, 2006; Livingstone, 2003, Somekh, 2007).

Despite this, there is also growing evidence suggesting that ICT can enhance and improve teaching and learning practices (Barrel, 2001; Kompf, 2005; Selwyn, 2006; Somekh, 2007; Wagner & Sweet, 2006). Today the use of ICT in education is regarded as something that has arrived to stay permanently (Cuban, 2001; Maeroff, 2003). However, many scholars stress that, although ICT can assist teaching and learning practices, it is critical to acknowledge that it is not an alternative to 'traditional' forms of education, but rather a complement to education (OECD, 2006; Selwyn, 2006; Somekh, 2007).

In the context of non-formal and community-based education (i.e. the types of educational contexts related to the present study, see Section 2.5), one issue with ICT is that both the implementation and the use are regarded as complex processes. This is because these educational contexts deal with different and autonomous adults and community-members "whose choices of how and what to learn" are not dictated by formal educational institutions (McNair, 2006, p. 157); and because of the rate of innovation and development of ICT-based tools, and its interrelatedness with other dimensions such as social, cultural and infrastructure conditions (Cuban, 2001; Somekh, 2007). This has resulted in a lack of understanding and knowledge about the full effects of the implementation of ICT in such learning environments (Cuban, 2001; Kompf, 2005; Somekh, 2007). It is suggested in the literature that systems thinking, socio-cultural theories (e.g. cultural-historical activity theory), and qualitative perspectives are useful approaches for the investigation of the

effects of the design, implementation and use of ICT in learning contexts (Kompf, 2005; McNair, 2006; Selwyn, 2006; Somekh, 2007; Webb, 2002).

A key issue concerning the use of ICT in non-formal educational contexts is that, according to some scholars, such learning contexts might promote transformative learning, which was identified in previous sections of this literature review as a key dimension underpinning 'strong sustainability', education for sustainability (EfS) and systems thinking. It is maintained that ICT-based non-formal education puts "the learner at the centre of the learning process" (Selwyn, 2006, p. 20), thus stimulating self-directed learning, which in turn, it is argued, might promote transformative learning (McNair, 2006; OECD, 2006; Pascual Leone, 1998). According to McNair (2006), as ICT-based non-formal educational settings are more likely to deal with individuals and their community's everyday problems and issues, the kind of learning that occurs tends to be more transformative than transmissive. Nonetheless, Selwyn (2006) points out that, although transformative learning "may be desirable, it is not dependent on the use of ICT or even necessarily encouraged by it" (p. 27), but rather on the social context and both the attitudes and perspectives of the learner.

In regard to the use of Internet and websites in education, Owston (1997) identifies at least three types of advantages offered: (1) the use of websites as a learning mode appears to be appealing to learners (i.e. in particular to young learners); (2) the Internet offers flexible learning possibilities (i.e. affordances); and (3) the Internet can enable new kinds of learning (Owston, 1997). In addition, the use of websites for online learning is commonly viewed in terms of the possibility of interconnectedness between learners, the independency of physical boundaries and time restraints compared to traditional forms of education, and the easier and quicker access to information (Owston, 1997; Wallace, 2004; Windschitl, 1998).

Regarding the affordances offered by websites that makes learning more accessible to more people, these have been identified within the literature

as being principally related to the graphical and multimedia aspects, the simplified access to information and databases, new Internet features such as Web 2.0 (i.e. web-technology that permits two-way interaction between users), and the constant growth of new technologies and dynamic softwares (Anderson, 2006; Barrel, 2001; Becta, 2008; Caladine, 2008; Clark et al., 2009; Owston, 1997; Pachler & Daly, 2009; Selwyn, 2006; Somekh, 2007).

On the other hand, and as mentioned earlier in the case of ICT in general, there are also barriers and constraints for the use of ICT and Internet websites for learning. The two main ones are that reliable ICT infrastructure is needed, which includes in this case reliability of computers, Internet connectivity and Internet-related software, and Internet-related skills on the part of users (i.e. ICT literacy), which will determine the degree of interaction between the computer and users (Becta, 2008; OECD, 2006; Pont & Sweet, 2006; Wallace, 2004; Windschitl, 1998). As noted above, the affordances that a particular user will be in position to engage in depends on the capacity to engage such affordances, for which Internet-related skills are needed (Dohn, 2009; Webb, 2005; Woo, 2009).

From these barriers, and from other research in the field, the real effectiveness and benefits for the provision of education using the Internet along with websites is yet to be fully understood (Barrel, 2001; Donoso & Roe, 2006; Cuban, 2001; Wallace, 2004; Windschitl, 1998). Nevertheless, literature increasingly supports the use of the Internet and websites for learning (Becta, 2008, 2009; Facer & Williamson, 2004; OECD, 2006; Somekh, 2007; Woo, 2009).

2.4.2.1 Use of ICT in education for sustainability

As mentioned earlier, in the context of the present study ICT, the Internet, and the use of websites are regarded as a means, or a tool, to facilitate education for sustainability (EfS) at the community level. According to the literature, the use of ICT for EfS is recommended by international

organizations, such as UNESCO (2003), principally because electronic dissemination of EfS is regarded as an inexpensive and effective way to disseminate knowledge and increase dialogue about sustainable living, and because ICT integration with EfS appears to be an important way to provide communities with new opportunities around socio-ecological sustainability issues (Phelps et al., 2008; UNESCO, 2003; Vrasidas, 2007).

In the context of the use of websites for education for sustainability (EfS), the literature indicates that this field is still relatively novel. Based on a review of all the issues of six key environmental education (EE) journals between 2000 and early 2006, Phelps et al. reported in 2008 that “very little, if anything has been written” about EfS Internet-based educational resources (Phelps et al., 2008, p. 46). Similarly, in 2003 Heimlich reported that “in a cursory review of 10 years of three of the journals dominant in EE, only 15 articles appeared that addressed computer or distance learning technologies in EE” (p. 5), with the majority of these articles only providing case studies of some applied uses of technology. Heimlich further stated, at least some years ago, that in the field of EfS there is a low level of awareness among educators and general practitioners concerning the existence and use of EfS websites (Heimlich, 2003). These reports reflect somehow the novel aspect of the use of ICT, the Internet and websites for the provision of EfS.

Despite the small amount of reported ICT in EfS research in the literature, and as mentioned before in regard to general aspects of ICT use, it has been argued that the use of Internet and websites for EfS can assist with the gathering and dissemination of information and resources, direct communication and networking, and for the deepening of understanding of environmental and sustainability issues (Aivazidis et al., 2006; Nomura, 2004; Phelps et al., 2008). In addition, it is suggested in the literature that the *effective* use of ICT, the Internet, and websites can not only enhance understanding of sustainability issues, but also promote participation in sustainable living, being both key concepts in this study (Aivazidis et al.,

2006; Linn et al., 2003; Nicolaou et al., 2009; Nomura, 2004; Schweitzer et al., 2008; Vrasidas et al., 2007). However, it is recognised that while ICT and websites can enable and assist the learning process related to EfS, it is crucial to acknowledge that it does not cause such processes to happen (Aivazidis et al., 2006; Nomura, 2004; Somekh, 2007).

As suggested earlier, in the present study the use of websites for education for sustainability (EfS) at the community level is regarded in relation to its potential to provide learning affordances to assist the promotion of both understanding and action for socio-ecological sustainability issues and challenges. The coming section presents a series of key website design ideas and considerations highlighted in the literature that is of use to inform the development of a theoretical model for the development of community EfS websites.

2.4.3 EfS websites design considerations

This section addresses some design considerations related to EfS websites. It has been reported in the literature that appropriate design considerations can enhance the affordances provided by EfS websites (Linn et al., 2003; Vrasidas et al., 2007). These considerations principally involve learning strategies for the use of ICT for EfS, design and multimedia considerations associated with the ICT affordances provided by EfS websites, and cultural considerations related to the social context of the target audience. Note that the focus of this section is to present theoretical ideas and considerations related to the design of EfS websites, rather than to present issues related to the design process.

2.4.3.1 Learning strategies as design considerations

The following learning strategies for the use of ICT for EfS come from studies reported in the literature. These include aspects such as to promote behaviour change and critical thinking in relation to the natural environment, or networking and partnership with relevant institutions. The presentation of these studies also intends to illustrate types of use of ICT for EfS from other educational contexts.

One of these studies reported in the literature is the RELATE project (i.e. 'Realizing Environmental Literacy through Advanced Technology and Experimentation') (Reeves, Affolter, & Lo, 1998). The RELATE project aimed to increase environmental literacy amongst undergraduate tertiary students using two major components: field experiments and a LSS website (i.e. LSS stands for 'learning support system'). The LSS website, characterised by being a cognitive tool (i.e. technology that enhances the cognitive powers of humans), was developed to function as a learning partner to enable critical thinking and higher order learning, in opposition to just being a medium to transmit information (Reeves et al., 1998). According to these authors, results from the RELATE project indicates that the use of the LSS website, along with field experiments, considerably increased the environmental literacy amongst students, and that students from an 'Ecology 100' course performed better on final examination questions related to the LSS websites than on the questions drawn from other aspects of the Ecology 100 course. Overall, the RELATE project highlights that the use of a LSS website could have improved the environmental literacy of tertiary students.

In another study on the use of ICT for environmental education, but in elementary/junior high school children and within a global context (i.e. the World School Network (WSN)), Nomura (2004) reported that the use of ICT and the Internet resulted in behaviour and attitude changes towards the environment. The objective of the study was to deepen children's understanding of environmental problems by presenting global perspectives. In order to achieve this, local environmental actions by school children from one area were shown through Internet websites to children from other regions. Though the ICT-based educational activities, complemented with face-to-face and off-line activities, Nomura (2004) reported that besides increasing knowledge, using Internet websites also stimulated the learning process through discussion sessions, resulting in cases of behaviour change. Despite the lack of methodological details regarding the assessment of behaviour change during this study, the author also indicates that such behaviour change in children also had a

positive impact on adults of the broader community. Finally, Nomura (2004) stresses that reliable ICT infrastructure, as well as face-to-face activities and partnership with strategic community members (e.g. teachers and parents), were essential for the success of the project.

Another project related to the use of ICT in EfS is the WISE project. This project was centred on the use of web-based science learning resources to promote science inquiry and knowledge integration for students from more than 25 countries around the world (Linn et al., 2003). The WISE project (i.e. 'Web-based Inquiry Science Environment') consists of a library of web-based resources developed by WISE design teams, with more than 1000 teachers and 100,000 students having run WISE projects. Many of these web-based resources addressed environmental issues promoting science learning. The WISE project framework recommends knowledge integration and inquiry as pedagogical approaches for EfS. This is based on the assumption that learners hold multiple and conflicting ideas and concepts about issues related to the environment and to sustainability (from a science perspective) (Linn et al., 2003). According to the WISE project framework, it is possible to achieve inquiry development in learners by following four principles (Linn et al., 2003, p. 524):

- Making thinking visible;
- Making science accessible;
- Helping learners to interact;
- Promoting life-long learning.

Note that in the context of this study, the second point 'making science accessible' could be regarded as 'making sustainability issues' accessible.

Based on the WISE project, and from the premise that education is an effective way to raise environmental literacy, Nicolaou et al. (2009) reported that after the application of the WISE framework on 11 and 12 year old students, there were significant differences between pre and post-tests, indicating improved environmental concerns, decision-making and critical thinking skills (Nicolaou et al., 2009). These authors add that 'authenticism' and relevance regarding addressed environmental and

sustainability issues are important factors to consider. Both Linn et al. (2003) and Nicolaou et al. (2009) reported that the WISE framework was promising in raising environmental literacy and decision-making skills. More recently, the WISE website reports that since 1997, it has served a growing community of more than 15,000 science teachers (WISE, 2013), 14,000 more than what reported by Linn et al., a decade ago (2003).

Although the WISE project was related to formal settings and is characterised by being a rigid, scaffolded framework, some elements of the WISE project can be related to non-formal EfS literature and may apply to community-based contexts. In particular, the idea of knowledge integration, which can be related to systems thinking in EfS; and the concept of inquiry, which can be linked to aspects of critical thinking present in the EfS literature (Ballantyne & Packer, 2005; Huckle, 1993; Huckle & Sterling, 1999; Sterling, 2005) can be considered. In addition, concepts from the WISE framework, such as making thinking visible (e.g. using ICT visual affordances), making sustainability issues accessible and promoting interactivity, are also key components of education for sustainability literature (Sterling, 2001; WWF, 2005); as well as of literature from systems thinking and complexity theory in education (Capra, 2005b; Davis & Sumara, 2005; Morrison, 2002).

Based on EE/EfS frameworks from Fien, Scott & Tilbury (2001) and Scott and Gough (2003), Monroe, Andrews and Biedenweg (2007) proposed a new framework for EfS that includes some key components to consider. These authors define four possible categories of interventions in the field of EfS: convey information, build understanding, improve skills, and enable sustainable actions (Monroe et al., 2007). As mentioned before, in the context of the present study these four categories are considered to fall within two key concepts: *understanding* of sustainability issues, and *action* towards ecological sustainability. It has been argued earlier in this literature review that these two EfS concepts, or the four categories from Monroe et al. (2007), can be integrated within the set of theoretical considerations for the development of EfS websites. Key ideas included in

the framework proposed by Monroe et al. (2007) are to achieve interaction and networking with involved institutions, community organizations, and end learners, in order to enhance participatory aspects of EfS interventions (Monroe et al., 2007). According to these authors, the success of EfS interventions "depends on the quality of interactions" between the involved parties (p. 210). Moreover, in the context of an EfS website, such interaction and networking may be achieved through the use of ICT affordances such as social media and Web 2.0.

The coming subsection explores different types of ICT-based affordances that may enhance the educational aspects of an EfS website.

2.4.3.2 Use of ICT features to enhance learning

The use of some ICT and Internet-based tools and features in non-formal and community-based education, such as multimedia representations like videos or animations, have proven to be helpful to make knowledge "much more accessible to learners than linear verbal texts" (Somekh, 2007, p. 30). In this regard, visual and audio media, simulations, modelling and other graphic and multimedia representations offered by ICT are considered to be effective ways to enhance teaching and learning practices (Linn et al., 2003; Mayer & Moreno, 2002; Roschelle, Pea, Hoadley, Gordin, & Means, 2000; Sangin, Dillenbourg, Rebetez, Bétrancourt, & Molinari, 2008; Webb, 2005; Woo, 2009). On the other hand, ICT features, such as Web 2.0 and social media can also enhance the learning process by promoting social interaction, which is believed to be at the core of social learning (Drexler, 2008; Guldberg, 2009; Tilbury & Wortman, 2008). The present subsection introduces some ICT-based features and affordances said to assist the learning through the development of EfS websites. These principally relate to multimedia affordances, and to Web 2.0 affordances.

The use of multimedia animations for educational purposes has received an increasing amount of support from a diversity of fields (Mayer & Moreno, 2002; Roschelle et al., 2000; Sangin et al., 2008; Webb, 2005).

As defined by Mayer & Moreno (2002), animation "refers to a *simulated motion picture* depicting movement of drawn (or simulated) objects" (p. 88). Animations are considered to be particularly suitable for the representation of dynamic systems based on the three main features of animations: picture, motion, and simulation (Mayer & Moreno, 2002; Sangin et al., 2008; Webb, 2005). In this regard, Mayer & Moreno (2002) propose seven principles for the design of multimedia representations involving animations:

> 1. *Multimedia principle* – Deeper learning from multimedia than from single-media alone.
> 2. *Spatial contiguity principle* – Deeper learning when corresponding text and animation are presented near rather than far from each other on the screen.
> 3. *Temporal contiguity principle* – Deeper learning when corresponding narration and animation are presented simultaneously rather than successively.
> 4. *Coherence principle* – Deeper learning when extraneous narration, sounds, and video are excluded rather than included.
> 5. *Modality principle* – Deeper learning from animation and narration than from animation and on-screen text.
> 6. *Redundancy principle* – Deeper learning from animation and narration than from animation, narration, and on-screen text.
> 7. *Personalization principle* – Deeper learning when narration or on-screen text is conversational rather than formal
>
> (Mayer & Moreno, 2002, p. 94)

In terms of the learning process, Mayer & Moreno (2002) report that the use of animations can be beneficial for learning, especially when the goal is to promote deep understanding, this being one of the two key components to be promoted within EfS websites (i.e. the other being *action*). However, animations are not "a magical panacea that automatically creates understanding. Indeed, the worldwide web and commercial software are replete with examples of glitzy animations that dazzle the eyes" (Mayer & Moreno, 2002, p. 97). This brings into the

discussion the cognitive theory of multimedia learning. A core idea underlying the use of multimedia for learning is to use as many human senses as possible to achieve full learning engagement (Woo, 2009).

In the case of multimedia, “only seeing, hearing, and feeling are used in most online multimedia learning” (Woo, 2009, p. 203). According to Magennis & Farrel (2007), research has shown that when presenting learners with auditive information, about 5% of the information may be retained, but when hearing and seeing are combined, learners can retain up to 20% of the information presented. More so, if the multimedia includes a demonstration in its presentation, the retention of information can increase up to 30% (Magennis & Farrell, 2007). The above findings suggest that multimedia representations that include both audio and visual information can be an effective learning tool (Woo, 2009).

On the other hand, when too much information is presented, either visual or auditive, both the perception and retention of information, and thus the learning process itself, might be compromised. This is what cognitive scientists call the *cognitive overload* effect (Low & Sweller, 2005; Mayer & Moreno, 2003; Sangin et al., 2008). Some common design practices to reduce cognition overload are to use both cognitive channels at the same time (i.e. vision and audition), to transform visual presentations into auditive forms, and to use short auditive representations (Woo, 2009). Woo also notes that auditory information tends to stay longer in the memory than visual information.

Regarding the potential use of multimedia features for EfS websites, multimedia features can represent natural phenomena, including temporal and spatial processes, more effectively than simple text of a static diagram. From a systems thinking and EfS perspective, the use of animations and multimedia to represent patterns and relationships between the components of sustainability issues may be beneficial for learning. This is in consideration that literature from systems thinking and EfS highlights the need to educate about the dynamism of ecological

systems and the existing connections with sustainability issues (CEL, 2009; Orr, 2004; Sterling, 2009). More on this follows in Chapter 5 addressing the design and development of an EfS website.

Another type of affordance offered by the Internet is what is known as Web 2.0. The term 'Web 2.0' refers to the posting of information on the Internet by users, generally within Web 2.0 application sites (e.g. Facebook, Twitter, MySpace, Flickr, some News websites, etc.). It has been proposed that Web 2.0 promotes interactivity, both between websites and users, and between users themselves, facilitating the creation and interaction of virtual communities, and promoting communication networks (Caladine, 2008; Drexler, 2008; Greenhow, Robelia, & Hughes, 2009; Guldberg & Mackness, 2009; Keeble & Loader, 2001a; Renninger & Shumar, 2002; Stolterman, 2001). In addition, Greenhow et al. (2009) suggest that interactivity of Web 2.0 promotes critical thinking skills due to the large amount of information available on the Internet, which requires users to critically consider and evaluate it.

Concerning the assistance for learning of Web 2.0, it is agreed amongst scholars that, at the moment, there is need of further understanding of both the learning process and the 'social web' (i.e. online social networks) before asserting if learning occurs with Web 2.0 (Ravenscroft, 2009). Ravenscroft (2009) further argues that the research focus in the field should be now on how to design better instances for learning, and on what are the right practices to adapt these processes to existing and emerging contexts, in order to make human learning better. Systems thinking and critical thinking are recommended as appropriate approaches for this (Davis & Sumara, 2005; Ravenscroft, 2009; Somekh, 2007).

In terms of the search for ideas to inform the development of EfS websites, the use of Web 2.0, along with theoretical considerations from systems thinking and community education, may enhance the learning process potentially occurring through the use of an EfS website. In particular, as presented above, Web 2.0 features are said to enhance

social interaction and communication. On the other hand, both systems thinking and community education literature argued that social interaction is at the basis of social learning and social transformation (Jorg, 2000; Sumara & Davis, 1997; Tilbury & Wortman, 2008). Therefore, using Web 2.0 features on EfS websites may enhance the interaction process between learners, which in turn may facilitate the learning process and the achievement of EfS goals at the community level. The final chapter of this thesis accounts for this potential use of Web 2.0 features for EfS websites.

In a more general aspect regarding the use of ICT-based affordances provided by educational websites, such as EfS websites, McGrenere & Ho (2000) identify two factors that influence the maximization of the usability of an affordance: the degree of perceptual information (i.e. clarity of information), and the degree of complexity in undertaking the affordance (see Figure 2.6) (McGrenere & Ho, 2000). These authors argue that as a design practice, the first goal should be to determine the necessary affordances to be designed and implemented, and then to enhance these affordances by maximising the two mentioned dimensions (i.e. the degree of perceptual information, and the degree of complexity in undertaking an affordance). Examples of affordance maximisation in websites are to increase the physical comfort of users (e.g. activate a simulation with a simple 'click' command), and reducing the performing time of an affordance (McGrenere & Ho, 2000).

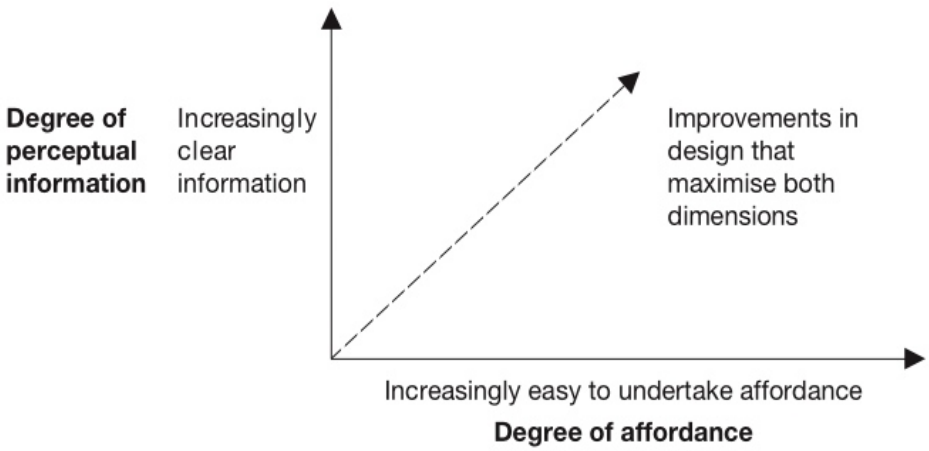

Figure 2.6. Affordance maximization based on perceptual information, and complexity of the affordance (McGrenere & Ho, 2000).

In consideration of the affordance maximization approach presented above, it has been suggested in the literature that combining different types of ICT-based affordances, like multimedia affordances (i.e. such as animations, videos, audio, and/or pictures), as well as Web 2.0 affordances, can expand the range of possible affordances offered by a website, and therefore, may be a possible way to further enhance ICT-based learning experiences (Caladine, 2008; Greenhow et al., 2009; Pachler & Daly, 2009; Ravenscroft, 2009; Roschelle et al., 2000).

In another perspective, it can be suggested that while designing and developing an EfS website, considerations regarding the maximization of affordances offered by an EfS website could facilitate the interaction between the website and the intended users. Interactivity, or the 'coupling process' that can occur between learning actors, is a key issue identified from systems thinking literature, in the sense that to promote the learning process, interactivity between learning actors is fundamental (Davis & Sumara, 2005). Such 'learning actors' could here refer to the users of an EfS website, *and* the EfS website itself. Therefore, maximizing the affordances offered by an EfS website can be critical for promoting a meaningful learning experience between the EfS website's users.

Similarly, the conditions for the 'creation' and 'nurturing' of complex educational systems (as discussed in Section 2.3.2) might be promoted by the affordances provided by Internet websites, as well as by other key issues discussed so far in this section (e.g. knowledge integration, networking and partnership). From a systems thinking perspective, the creation, stability, nurturing and endurance of educational systems is subjected to some key conditions, such as: interactivity, diversity, and means for learners to affect each other (Davis & Sumara, 2005). Each one of these key conditions could, in one way or another, be addressed and implemented during the design process of EfS websites.

As a way to move into the next subsection addressing socio-cultural considerations regarding the design process of Internet websites, it has

been reported that both the reasons and the way that ICT-based affordances and materials are designed considerably influence the effectiveness of learning experiences (Wallace, 2004).

2.4.3.3 Socio-cultural considerations for the design of meaningful ICT affordances

When designing a website, and particularly EfS websites, it is critical to clearly identify the social and cultural context of the target audience/users (Dunn & Marinetti, 2008). Research highlights the importance of the social context and the understanding of the cultural needs in the shaping of Internet-based materials (Kling, 2000; Knight et al., 2009; Selinger, 2004; Woo, 2009). This subsection presents website design aspects related to effectively addressing the characteristics and needs of a target audience.

From a study about cultural interpretations of icons from academic websites, Knight et al. (2009) report that globalization and the spreading of the Internet call to cultural considerations, particularly regarding the design of culturally significant icons and images on websites (Knight et al., 2009). According to Knight et al., "the particular meaning of an image is often bound to the cultural context in which it was designed, and its intended meaning may well be changed, diminished or lost when viewed within other cultures" (Knight et al., 2009, p. 18). Based on this, Chu and Martinson (2003) state that to clearly define and address the target culture is vital during the design stage of any intended website in order to achieve meaningful experiences between the website and users (Chu & Martinson, 2003). Some key issues for designing culturally meaningful websites are a pre-design research phase, message and information clarity, and good understanding of the ICT structure of the target culture (Dunn & Marinetti, 2008; Hall, 1989; Knight et al., 2009).

Similarly, from a study about effective learning strategies for cross-cultural audiences, Dunn and Marinetti (2008) highlight some issues that website designers face while developing instructional systems for culturally diverse environments. The authors define instructional systems as "learning

products or services" (e.g. ICT, educational websites, etc.), and point out that such products are shaped by the culture in which, and for which, they are designed (Dunn & Marinetti, 2008, p. 156). These authors particularly stress that the most critical part of the design process of instructional systems is a conscious and culturally-informed selection of learning strategies. Dunn and Marinetti (2008) report that during the design phase of instructional systems, at some point decisions about the learning strategies to be used are made, implicitly or explicitly. Thus, it is not only important to take into account cultural values of the target culture, but also the values of the designer him/herself, who is immersed within a set of cultural values too, and largely influenced by them (Dunn & Marinetti, 2008).

Another important design consideration for the development of meaningful EfS websites is to include users' perspectives and needs during the design process. This is what is known as 'user-informed', 'user-centred', and/or 'user-driven' design, which are different types of strategies that consider the involvement of users in the design process of products (Baihong & Wanli, 2003). Since the late 1970s and early 1980s, the idea of focusing on the users' characteristics and needs in order to ensure that a particular designed product will meet users' requirements in the expected context of use has gradually penetrated the design cycle and practice of consumers' products, as a way to improve the 'quality of use' of products (Beyer & Holtzblatt, 1998; Facer & Williamson, 2004). There are two main types of user involvement: 'user-driven' design, which means the direct involvement of potential users in the design process; and 'user-informed' design, that is, the user is approached as a source of information regarding the context of use, generally through field studies, focus groups and interview methods (Baihong & Wanli, 2003).

In terms of the involvement of users in the design of EfS websites, this process accounts for at least two key theoretical considerations. Firstly, it provides means for diversity of perspectives, which according to Davis and Sumara (2005), contributes to the nurturing of educational systems. And

secondly, from a community education perspective, the input provided by local community members in the design of an EfS website targeting sustainability issues existing in their community provides accounts of what constitutes real-life, local, and relevant issues to target users. The user-informed approach usually requires considerable user involvement over long periods of time, and therefore is not always possible because of time constraints (Baihong & Wanli, 2003). Also, users are not always 'good designers', which has resulted in less adoption of the user-driven design approach (Morgan & Krueger, 1998; Nielsen, 1993).

Regarding the context of the Internet and websites, the handbook *Designing educational technologies with users* (Facer & Williamson, 2004), focused on the use of technology for learning (i.e. www.futurelab.org.uk), provides valuable literature and guidelines on user-informed design strategies for the development of technology-based educational resources such as EfS websites. It is argued that designing learning environments including participation of users in the design process can be a beneficial approach for learning with technology (Facer & Williamson, 2004).

In this context, the benefits of user involvement are mainly to avoid design misinterpretations, or 'pitfalls', and to have first-hand experience of the socio-cultural learning needs, interests, and skills of users in order to develop meaningful websites (Facer & Williamson, 2004). In Table 2.4, four common approaches for user involvement are presented. The suitable approaches for a given project will depend on different factors related to the project's setting. In addition, some further recommendations (Facer & Williamson, 2004) regarding the involvement of users for the design of technology-based educational resources are to introduce end-users into the design process as early as possible, to be clear regarding the roles in the design process, and to establish networking and partnership with advisors and collaborators.

Table 2.4. Four different approaches for user involvement in intervention design contexts (adapted from Facer & Williamson, 2004).

Approach	User roles	Aims	Common techniques
Ethnography and User observation	Users observed in existing activities and/or in natural settings using prototypes	To understand how users operate under existing conditions. To identify opportunities for new resources	Video, observation, field notes
User testing	Users observed trialling technologies and asked to provide feedback	To understand how users interact with new resources	'Talking aloud' during use, interviews, observations
Informant design	Users seen as experts or 'native informants' informing designers of key issues related to their experience	To generate new ideas about the needs and preferences of users	User panels, focus groups, and trials at specific stages of development
Participant design and cooperative inquiry	Users working as a core part of a design team to identify ways of improving the environments for learning	To enable democratic design and decision making in collaboration with users	Users seen as equal partners of the design team. Comprises different phases according to expertise

2.4.3.4 Other key design considerations

This final subsection briefly presents three key design considerations, related to the design and development of EfS websites that fall outside the scope of the previous three subsections:

- Training for educators: ICT training for EfS educators is highlighted as relevant, and recommended in order to further facilitate the learning process that occurs amongst users of EfS websites (Aivazidis et al., 2006). The premise here is that the more ICT literacy EfS educators possess, the more they will be able to engage with the website design team during the development of an EfS website, which may be beneficial for the final affordances offered, as well as for the overall web design process.
- Testing of pilot: As part of the design process of EfS websites, Linn et al. (2003) and Facer & Williamson (2004) put emphasis on the testing of a pilot website, in order to assess if the desired outcomes are achieved, and to ensure that the social context is effectively addressed to connect learners' motivation and concerns with the chosen website subject.
- Systems thinking approach: Literature reports that EfS combined with ICT within a holistic and systemic approach to education is an effective way to enhance EfS educational programmes (Vrasidas et al., 2007). For example, when addressing a particular sustainability issue in an EfS website, it is important to provide complete background information in the relations and connections existing between the addressed sustainability issue with other related dimensions and issues, as a way to provide the big picture (i.e. instead of just addressing the particular sustainability issue alone) (Schweitzer et al., 2008).

This section has presented a range of web design considerations from different fields and perspectives. Table 2.5 below summarises all these design considerations as a reference for the development of the theoretical model for the development of EfS websites.

Table 2.5. Key ICT-related design considerations for the design and development of EfS websites.

1. Learning strategies / Characteristic	
Knowledge integration and Inquiry	Knowledge integration of, and critical thinking around, sustainability challenges and related issues (Linn et al., 2003; Nicolaou et al., 2009).
Relevance	Addressing authenticism and real-life issues (Nicolaou et al., 2009).
Systems Thinking	Relate particular local sustainability issues with other related issues as a way to provide the 'big picture' (Schweitzer et al., 2008).
2. Design considerations / Characteristic	
Animations and Multimedia	Use of animations and other multimedia features to enhance the affordances provided by websites (Mayer & Moreno, 2002; Sangin et al., 2008; Webb, 2005; Woo, 2009).
Web 2.0	Use of Internet and Web 2.0 features to enhance interactivity and community networking (Greenhow, 2009; Ravenscroft, 2009).
Social and cultural context	Clearly define and address the target culture and social context (Chu & Martinson, 2003; Dunn & Marinetti, 2008; Knight et al., 2009).
User-informed design	Involvement of end-users in the design and development process of EfS websites (Baihong & Wanli, 2003; Facer & Williamson, 2004).
Affordance maximisation	Maximize the affordances offered by a website (Greenhow et al., 2009; Webb, 2005).
Users' conceptions	Understand the range of possible conceptions of users around a sustainability issue (Dohn, 2006; Webb, 2005; Woo, 2009).
Testing of pilot	Ensures the target culture is addressed, and assesses if desired outcomes appear (Facer & Williamson, 2004; Linn et al., 2003).

3. Other key issues / Characteristic	
Networking and Partnership	Importance of networking and establishing partnerships with local communities and related organizations (Facer & Williamson, 2004; Monroe et al., 2007; Nomura, 2004).
ICT training	ICT training for EfS educators as a means to further enhance the learning process of EfS websites (Aivazidis et al., 2006).

Webb (2005) points out in a study about ICT affordances in science learning that to be aware of, and understand, the range of possible conceptions held by learners is crucial in the design of affordances. Understanding such conceptions should be part of the 'pre-design research' process, as advocated by Knight et al. (2009) and Facer & Williamson (2004).

2.4.4 Summary

Education for sustainability (EfS) through ICT encompasses a broad range of issues related to different fields. The literature reviewed in this section indicated that ICT, and particularly Internet websites, can potentially assist education for sustainability. Whether using different ICT-based features, or by making knowledge accessible to learners, there are different reports supporting the use of ICT for EfS at the community level. In this sense, some experiences related to formal educational settings reported in this section indicated positive EfS outcomes reached using ICT tools. For example, learning strategies from the WISE project, such as enhancing knowledge integration on learners (Linn et al., 2003), seems to be potentially useful for the design and development of EfS websites. In particular, knowledge integration was said to promote critical thinking, a key educational components within EfS.

Different design considerations that can be used to enhance the affordances offered by EfS websites were also discussed. Some design considerations highlighted in the literature are the understanding of the ICT infrastructure, as well as of the cultural and social contexts of the

target audience. Other considerations regarding ICT features highlighted as relevant for EfS were the use of multimedia and Web 2.0 affordances, which can assist the learning process for learners based on an EfS website. In addition, involvement of end-users during the design process of EfS websites, and the understanding of learners' existing conceptions regarding a particular sustainability issue, may further extend the potential of websites for community EfS.

At this point, this literature review has addressed three major components around EfS: sustainability, systems thinking and ICT. As mentioned before, one of the aims here is to integrate these components for the development of a theoretical framework that informs the design of EfS websites for non-formal community education. In the coming section, the concept of non-formal community education is reviewed with the aim of providing further insights of the use of EfS websites at the community level. The coming section addresses issues related to community education, where the understanding of the different conceptions held by community members, as well as carrying out a pre-design research phase, appear to be critical for the design of EfS websites aimed at the community level.

2.5 Education for sustainability using ICT in the community

This section addresses the concept of 'community' in relation to the implementation and use of EfS websites. Since *Agenda 21* (UNCED, 1992), EfS at the community level has gained increasing support as a means to address sustainability issues and challenges (Tilbury & Wortman, 2008; Zachariou & Symeou, 2008). Moreover, as sustainability challenges are recognised as immediate and urgent, EfS at the community level appears to engage the general public and community members in social change towards ecological sustainability, compared to formal EfS programmes, where the expected outcomes are long-term and less influential in the immediate term (Tilbury & Wortman, 2008; Uzzell, 1999).

Nonetheless, today it is recognized that, although there are indications of high levels of awareness of sustainability issues amongst the general public and community members, there is still a relative lack of knowledge and understanding of these issues (Bolstad, 2003a; McLean, 2003; Orr, 2004; Oulton & Scott, 2000; Sterling, 2001). This poor understanding of the issues related to sustainability challenges seems to be related to insufficient educational initiatives undertaken so far (Chapman & Eames, 2007; Fien, 1997, 2000; Huckle, 1991; Walker, 1997). On the other hand, there is growing evidence that Information and Communication Technology (ICT) can be a significant tool to assist and enhance community-based EfS programmes (Aivazidis et al., 2006; Nomura, 2004; Somekh, 2007; Vrasidas et al., 2007). This suggests that the use of EfS websites can be an effective means to deliver EfS in communities.

This section is divided into two parts. The first part reviews key characteristics of community-based and free-choice education. The second part explores the need for EfS at the community level, and some notions of community networking and communication through the use of ICT and the Internet. It is argued that community networking can contribute to further promote understanding and active participation towards socio-ecological sustainability amongst community members.

2.5.1 Community and education

In the present study, the provision of education for sustainability (EfS) is aimed at the community level. The concept of ‘community’ is recognised in the literature as complex, broad and difficult to define, as it can be multidimensional in scope and perspective, generating a whole range of possible definitions and approaches (Brookfield, 1983; Galbraith, 1990b; Thompson, 2002; Tight, 2002). After analysing more than ninety definitions of 'community', Warren (1978) noted that nearly two-thirds of them emphasized concepts such as human interaction, interrelationship, values and common interests.

During the 1980s, Brookfield (1983) argued that in contemporary Western societies, characterised by pluralism and social mobility, recognition of cohesive and place-based groups of people could be difficult to observe empirically. This view has led to a focus in the concept of community from ‘geographical’ communities to ‘what can be observed’, that is, a focus on communities of interests (e.g. rugby fans) and on communities of function (e.g. dairy farm owners, social workers) (Brookfield, 1983; Hugo, 2002). More recent approaches, especially within EfS literature, highlight the notion of 'social interaction' as the essence of what is understood by ‘community’ (Capra, 2005b; Krasny & Roth, 2010; Tilbury & Wortman, 2008).

Similarly, education at the community level, or ‘community education’, encompasses a broad range of perspectives, concepts, and “imprecise definitions”, such as ‘adult learning’, ‘adult education’, ‘learning in adulthood’ and ‘community learning’ (Hugo, 2002, p. 6). For the purposes of the present study, the term *community education* is chosen for referring to the learning process that occurs amongst the general public (i.e. adults) at the community level. Hence, community education is the type of education (i.e. non-formal and/or informal education) that occurs within the community (Galbraith, 1990b). Many scholars argue that the process of learning and the concept of community are deeply rooted and interconnected, in the sense that the learning process for individuals is dependent on social interaction and communication (Boyer & Roth, 2005; Brookfield, 1990; Hugo, 2002; Jorg, 2000; Sumara & Davis, 1997; Webler, Kastenholz, & Renn, 1995). As stated by Brookfield (1990) in the context of adult learning, “adults’ structures of understanding evolve as they interact with the various agents of socialization” (p. 63).

Community education involves many different issues. The following list presents some relevant characteristics, issues and concepts involved within the concept of community education:

- Community education is a life-long activity;

- There is great stress on transformative processes (i.e. learner's needs);
- There is strong emphasis on learner's active participation and decision-making;
- Community education generally addresses and deals with problems and needs of the community;
- Community education can be based within identifiable communities and groups;
- Community education generally encompasses informal and non-formal methods and contexts (i.e. self-directed).

(Brookfield, 1983; McConnell, 1997; Thompson, 2002; Tight, 2002)

Another important issue within non-formal and informal community education, in the context of adult learning, is that the learning process in which community members engage is principally self-directed and governed by an individual's learning needs and motivations (Brookfield, 1986; Chobot & Chobot, 1990). Such an educational environment is often called 'free-choice' learning in the literature, which is a form of learning that is "self-directed, voluntary, and guided by individual needs and interests" (Falk & Dierking, 2002, p. 9). Although the main focus on free-choice learning settings has historically been zoos, aquariums, museums, and science and technology contexts, the mass media (e.g. TV, radio, newspapers) and new Information and Communication Technologies (ICT) along with the Internet also offer free-choice learning opportunities (Boyer & Roth, 2005). Hence, as free-choice learning settings are self-directed and voluntary, choices need to be made by learners when it comes to "what, why, where, and how learning will occur" (Galbraith, 1990a, p. 89), whether learners realize it or not (Tight, 2002). According to Galbraith (1990a), the first choice to be made is to decide whether a learning need exists or not; this is followed by determining the purpose of such learning, and the consequent level of interest of the particular learning need.

Another aspect of community education is that community members as 'individual learners' are characterised by their different cognitive and

intellectual backgrounds, expectations, needs, level of engagement and motivations for pursuing learning activities (Brookfield, 1990; Linn et al., 2003; Menzel & Bögeholz, 2008). Such a cohort of individuals involved in learning activities points to the fact that community members constitute a broad audience. Therefore, in order to satisfy each individual's learning needs, community-based educational programmes should offer a wide range of learning opportunities, including variety in intensity and sophistication (Brookfield, 1986; Chobot & Chobot, 1990; Galbraith, 1990b). Related to this last point, as different individuals possess different cognitive backgrounds, "the learner's perspectives are key factors in making educational measures meaningful or meaningless for an individual" (Menzel & Bögeholz, 2008, p. 430).

According to constructivist perspectives, when faced with new information, individuals actively and subjectively generate their own knowledge by either accommodating (i.e. adapting) their own cognitive structure, or by assimilating information, in order to fit it in their current worldview (Kelly, 1991; Piaget, 1955). In this context, literature from science education informs that achieving change in conceptual structure, and thus accommodation of information, is often difficult (Posner, Strike, Hewson, & Gertzog, 1982; Vosniadou, 1992). Based on the tendency to stability of conceptual structures in learners, Menzel and Bögeholz (2008), citing Duit & Treagust (2003), argue that prior established knowledge and ideas may be an obstacle for the acquisition of new information and knowledge related to sustainability issues. Hence, by being aware of the cognitive framework (i.e. conceptual structure) of learners, educational interventions "can actively address prior existing cognitive frameworks to enhance the learning process" (Menzel & Bögeholz, 2008, p. 431). This issue was noted earlier in Section 2.4 'EfS through ICT', in relation to the design of meaningful educational websites (Chu & Martinson, 2003; Knight et al., 2009; Webb, 2005).

Concerning the issue of informal and non-formal educational methods and contexts, which are the major contexts occurring in community education

and free-choice learning, the use of EfS websites for community education, as approached in this study, appears to be related to non-formal kinds of settings. Both informal and non-formal types of education are characterised principally by occurring outside formal educational institutions (e.g. schools, universities, educational centres) (Galbraith, 1990b; Thompson, 2002; Tight, 2002). For these two types of education, the major difference lies in that non-formal education learning activities are explicitly and systematically organized to serve and benefit a particular group and/or community, including specific learning objectives (Galbraith, 1990b; Thompson, 2002). Whereas, informal education is rather referred to as "the learning that goes on in everyday life" (Thompson, 2002, p. 10), it may be deliberate or fortuitous, but is always meaningful to the learner (Galbraith, 1990b). In addition, Galbraith notes that informal education is the main form of education that takes place within the community. In this sense, and as stated by Tight (2002), "we are all, as children and as adults, engaged in learning every day of our lives, whether we realize it or not" (p. 1).

According to the above discussion, the type of learning that might occur when community members use an EfS website, within the approach of the present study, is associated with non-formal and free-choice contexts. This is because the learner is who chooses "how and what to learn" (McNair, 2006, p. 157), and because such EfS websites are organized for the community, including implicit learning goals, which are, in this study, to promote understanding and action around socio-ecological sustainability issues. Thompson (2002) stresses that community education can both "help to build on what people already know from their own experience with new knowledge and skills that could make a qualitative difference to their lives"; and "provide some of the glue that connects 'issues' to 'ideas', and 'understanding' to 'practical action'" (p. 10). These ideas of how non-formal community education can contribute to link understanding with action and skills around sustainability issues are further explored in the coming section.

2.5.2 EfS using ICT in the community

As suggested above, in the field of education for sustainability (EfS) non-formal community education is regarded as an important means not only to raise people's awareness and understanding over sustainability issues and challenges, but also for engaging community members to move towards more sustainable ways of living (Fagan, 1996; Orr, 2004; Thompson, 2002; Tilbury & Wortman, 2008). Nonetheless, it has been reported that traditional, community-based, environmental education (EE) programs focusing only on raising awareness "have not led to widespread changes in the actions of individuals, government, and the private sector to address the root causes of environmental and sustainability challenges" (Tilbury & Wortman, 2008, p. 85), and thus, a more action-oriented and learner-oriented approach is necessary to effectively achieve outcomes that will contribute to a more ecologically sustainable world (Fien & Tilbury, 2002; Jensen & Schnack, 1997; Sterling, 2001, 2005). Appropriate knowledge and understanding are the basis of an informed opinion, which in turn enables meaningful decision-making processes and meaningful community active participation (Myers, 2005; PCE, 2006; Sterling, 2001; Tilbury & Wortman, 2008; WWF, 2005).

For the last two decades, non-formal education for sustainability (EfS) at the community level has received increasing attention and support (Tilbury & Wortman, 2008; Zachariou & Symeou, 2008). This is because EfS educators have recognized that sustainability issues and challenges are immediate and locally rooted in context, and thus, require participative action by local communities under the premise that adults rather than children are the ones that have to engage in action and change towards sustainability (Tilbury & Wortman, 2008; UNCED, 1992; Uzzell, 1999). Nonetheless, it should be noted that non-formal community EfS and school-based formal EfS should be interdependent, complementary and receive equivalent attention.

Although several studies have shown an increase in public awareness and participation in environmental and sustainability issues, it is recognized

that misinformation, lack of information, and poor understanding of information concerning environmental and sustainability issues and challenges exist as well (Bolstad, 2003a; Fien, 2000; McLean, 2003; Orr, 2004; PCE, 2006; Sterling, 2001; UNCED, 1992). This is a matter of importance as relevant education at the community level around the concepts of public *understanding* and community *active participation* (or 'action'), is considered critical for the achievement of ecological and transformative sustainability (Räthzel & Uzzell, 2009; Tilbury & Wortman, 2008; UN, 2002a, 2002b; UNESCO, 1997; WWF, 2005). Blincoe (2009) argues that a new educational platform is needed, as well as new educational methodologies that account for body, mind and soul, with more positive ways of communication about sustainability issues.

In this context, as a possible way to promote and raise both understanding and action at the community level, it has been argued in this review that ICT and the use of EfS websites might assist non-formal education for sustainability (EfS) programmes by enhancing the understanding of sustainability issues, and by promoting community members' active participation towards strong sustainability (Nicolaou et al., 2009; Phelps et al., 2008). According to the literature, it can be suggested that ICT-based non-formal EfS at the community level can contribute to making the links between ideas and concepts (i.e. understanding) with participative and action skills (Nomura, 2004; Thompson, 2002). Therefore, the use of ICT, particularly EfS websites, appears as a promising way to engage social change for sustainability at the community level, and as a significant medium for the provision of non-formal community education for sustainability (Phelps et al., 2008; UNESCO, 2003).

In community EfS literature, the concept of social interaction is regarded as a key component for both social learning and social transformation towards ecological sustainability (Tilbury & Wortman, 2008; Webler et al., 1995). According to Webler et al. (1995), the learning process of individuals is dependent on social interaction, and, when community members interact and become involved in collective participation, they

mature into responsible citizens (Webler et al., 1995). It was argued in Section 2.4 ‘EfS through ICT’ that the use of EfS websites not only can be a significant medium for the dissemination of knowledge related to sustainability challenges, and for the promotion of active participation for sustainability, but also that some ICT and Internet features (i.e. Web 2.0 affordances) have the potential to facilitate and promote interactivity, communication and networking between users (i.e. community members) (Davis & Sumara, 2005; Jankowski, Van Selm, & Hollander, 2001; Keeble & Loader, 2001b; Linn et al., 2003; Nicolaou et al., 2009; Ravenscroft, 2009).

Within the same line of reasoning, Keeble and Loader (2001) argue that “computer-mediated social relations are depicted as the conduit through which new forms of community structure and culture can evolve though spontaneous electronic interaction” (Keeble & Loader, 2001b, p. 1). Many governments and policy-makers have recognized the importance of facilitating online social interaction, which has resulted in an increasing promotion of ICT and Internet literacy worldwide (Casapulla, De Cindio, & Ripamonti, 2001; Keeble & Loader, 2001a, 2001b; UNESCO, 2003).

As mentioned earlier in this review, ICT infrastructure and access to Internet are critical for the use of ICT for EfS at the community level (Nomura, 2004). In addition, “a public sphere in cyberspace will not emerge from technology itself. Rather, this public sphere must be designed” (Stolterman, 2001, p. 43). Stolterman (2001) further argues that such a public sphere must be designed from the community itself, addressing problems and challenges according to local needs. In other words, to achieve a meaningful EfS website, sustainability issues must be locally rooted, relevant, and the community itself should be involved in some phases of the design process of the website (i.e. ‘user-informed design’, see Section 2.4.3), which calls for partnership and networking with community-based organizations (Nomura, 2004; Thompson, 2002).

Moreover, it is also recognised within the literature that, in order to promote the use of digital social networking, community members need support, help and motivation "to understand why and how making the effort to learn" with the Internet is worthwhile (Casapulla et al., 2001, p. 89). According to the literature, such motivation for the use of EfS websites might be achieved by addressing the affective and emotional domains of EfS through real life and local context issues (Nicolaou et al., 2009; Sipos et al., 2008). Ballantyne & Packer (2005), citing Eich & Schooler (2000), highlight the importance of addressing emotions in EfS free-choice learning contexts in stating that "recent theories of learning have started to take greater account of the role of emotion in learning" (p. 288).

According to the literature, arousing emotions, as well as using learner's motivations, are only two of a range of factors that can contribute to the adoption of 'environmentally sustainable' attitudes and practices amongst learners (Ballantyne & Packer, 2005; Hofreiter et al., 2007; Linn et al., 2003). Other important factors reported by Ballantyne & Packer (2005) are challenging personal beliefs (i.e. personal constructs related to sustainability issues), and enhancing sustainability-related conceptions. Challenging personal beliefs implies to help learners to be aware of their own alternative conceptions and beliefs regarding sustainability issues, and to assist them to confront these with new information (which is related to enhancing learners' sustainability-related conceptions) (Ballantyne & Packer, 1996, 2005; Menzel & Bögeholz, 2008). The theory of cognitive dissonance (Festinger, 1957) originally proposed that "if a person held two cognitions that were psychologically inconsistent, [they] would experience dissonance and would attempt to reduce dissonance, much like one would attempt to reduce hunger, thirst, or any drive" (Aronson, 2007, p. 117).

Thus, in order to facilitate the adoption of new concepts consistent with strong sustainability perspectives, learners should challenge their own conceptions against new information (i.e. cognitive dissonance), and make sense of that 'new information' (Aronson, 2007; Ballantyne & Packer,

2005; Festinger, 1957; Menzel & Bögeholz, 2008). This brings into discussion the '*evidence, effects* and *efforts*' approach from Ballantyne, Fien & Packer (2001), which, according to these authors, is a "powerful" (p. 290) way to help learners to challenge their own environmental and sustainability conceptions by:

> Focusing on the *evidence* of an environmental problem (particularly in relation to human impact and mismanagement), the *effects* of the problem (particularly in relation to wildlife and wildlife habitats), and the *efforts* needed to alleviate the problem (practical steps the learner can take).
>
> (Ballantyne & Packer, 2005, p. 290)

It is argued in the literature that understanding of learners' prior conceptions is vital for the design of meaningful learning experiences in free-choice environments and contexts (Ballantyne & Packer, 2005; Chu & Martinson, 2003; Duit & Treagust, 2003; Kelly, 1991; Menzel & Bögeholz, 2008).

Concerning community education interventions, Thompson (2002) suggests some guidelines for the development of community-based education programmes, which in the context of the present study would be related to the pre-design phase mentioned in Section 2.4 'EfS through ICT' concerning the development of EfS websites:

> *1. Getting started:*
>
> • Ask for people's advice. Listen to what they say – even if is not what you want to hear
>
> • Spend time in the community
>
> • Take time to talk to people informally
>
> • Try to get a feeling of the issues and understand them
>
> *2. Listening campaigns:*
>
> The main purpose is to find out what issues people have strong feelings about, in the belief that people are more likely to get involved in action and activities about things that concern them. Partnership with local residents and institutions is critical.

3. Partnership working:

• Decide which agencies/organizations are relevant

• Make contact with people in them who you know have similar interests and shared enthusiasms

• Get together to share information about your work and to identify areas of overlap and opportunities for joint working

(Thompson, 2002, pp. 16-22)

In this section, it has been argued that EfS at the community level is becoming increasingly important in the international literature as a means to promote social change towards ecological sustainability. In addition, the literature also suggests that the use of websites could assist and facilitate the provision of EfS at the community level. As reviewed in this section, this process involves many different issues and concepts, from learning strategies in community-based and free-choice learning settings, to a focus on social interactivity instances offered by ICT, Internet, and websites. As well, it has been argued that the combination of community education and free-choice learning methods with the use of websites for EfS can promote the links existing between understanding of sustainability issues, and action towards ecological and transformative sustainability.

As a way to highlight key aspects from this section to inform a theoretical framework for community EfS website development, Table 2.6 summarises key aspects related to EfS using ICT in the community. In particular, it organizes the ideas discussed in this section under ‘characteristics of non-formal community education’, such as the notion of promoting social interaction or addressing locally relevant issues; and under ‘community education components for EfS’, which includes learning approaches from community education relevant to EfS, e.g. political literacy and addressing affective domains in learning.

Table 2.6. Key components in non-formal community education for EfS.

I. Characteristics of non-formal community education	
Social interaction	Social interaction is regarded as a key condition for both social learning and social transformation (Tilbury & Wortman, 2008; Webler et al., 1995).
Transformative process	Community education involves emphasis on transformative processes (Brookfield, 1983; McConnell, 1997; Thompson, 2002; Tight, 2002).
Active participation	Community education involves active participation and involvement by community members (Brookfield, 1983; Stolterman, 2001; Thompson, 2002; Tight, 2002).
Real-life, local context and relevance	Community education deals mainly with a community's needs, problems and issues, involving immediate, relevant and locally rooted issues (Brookfield, 1983; Nomura, 2004; Tilbury & Wortman, 2008; Thompson, 2002).
Free-choice learning	Community education offers free-choice learning context, characterized by being self directed, voluntary, and depending on individual's needs (Boyer & Roth, 2005; Falk & Dierking, 2002; Galbraith, 1990).
Broad audience	Community educational interventions deal with broad audiences, which demands a wide range of variety, intensity and sophistication of interventions (Brookfield, 1990; Menzel & Bögeholz, 2008).
II. Community education components for EfS	
Political literacy	Importance of democratic and decision-making skills, and participation from community members (Myers, 2005; PCE, 2006; Sterling, 2001, 2005; Tilbury & Wortman, 2008).
Learner conceptions	Importance of understanding the range of alternative conceptions held by learners (Ballantyne & Packer, 2005; Chu & Martinson, 2003; Kelly, 1991; Menzel & Bögeholz, 2008).
Affective domain	Importance of addressing emotions and affective domain for learning (Ballantyne & Packer, 2005; Nicolaou et al., 2009; Sipos et al., 2008).

Challenging beliefs	Challenging beliefs to help the adoption of new information through cognitive dissonance (Aronson, 2007; Ballantyne & Packer, 2005).
Networking and partnership	Importance of networking and partnership in community-based EfS interventions (Thompson, 2002).
Positive ways of communicating	Importance of adopting positive ways of communicating and disseminating about sustainability issues and challenges (Blincoe, 2009).

2.5.3 Summary

From this section, the key notions in relation to the present study are that non-formal community EfS has received increasing recognition and support amongst EfS scholars. The idea of educating adults for community-based sustainability through free-choice settings is as relevant as educating pupils for future challenges related to sustainability issues (i.e. because sustainability issues are urgent and locally rooted, requiring immediate action).

Another key concept from this section is the notion of 'digital' social networking, or the use of interactive websites for community communication and networking. Community communication and social relations are at the core of learning processes, and thus, of community EfS. The use of new communication technologies such as the Internet appears to be highly relevant, and to have great potential for the provision of community EfS. In regard to the present research study, the use of EfS websites for non-formal community-based EfS is an area that needs further research and development. The final section of this literature review presents a summary of the key ideas and concepts presented throughout this review, organized in the form of a framework for the use of EfS websites for community education, and around the key components of this study: sustainability, education, systems thinking, and ICT.

2.6 Summary

The literature presented in this chapter constitutes the theoretical structure on which this study is based. As the objective of this study is to investigate the use of ICT for community EfS by means of Internet websites, and within a systems thinking approach, it was necessary to review literature from each one of those fields of knowledge. First, the concept of 'sustainability' was addressed. As there are many perspectives associated with this term, it was necessary to review the origin and different existing views related to it, in order to clearly define what the term sustainability entails in this study. The term sustainability is defined and understood here as *ecological sustainability*, which relates to the notion of attaining our *needs* by living in harmony with the planet's ecosystems balance. In addition, the concept of ecological sustainability as approached here involves five core ideas (i.e. thinking/paradigm shift; systems thinking; ecological literacy; long-term thinking; and ethics and values). Within this view of the concept of 'sustainability', the second step was to review the concept of education for sustainability (EfS).

EfS is regarded in this study as an educational approach to address current socio-ecological sustainability issues and challenges. In particular, EfS is seen here as an effective way to empower people at the community and non-formal level towards ecological sustainability. The two key EfS concepts underpinning this view are the promotion of understanding of sustainability issues, and action towards sustainable living. Different aspects and approaches of EfS were reviewed and presented, with the goal of identifying key aspects that can assist the development of a theoretical framework for the use of ICT in community EfS. These key aspects were highlighted throughout the chapter, and summarised in the tables presented in this chapter.

In regard to the use of ICT for community EfS, literature stresses the need for a systems thinking approach in order to deal with the complexities existing within such types of educational settings. This brought attention to the concept of systems thinking in the third section of this chapter.

Systems thinking is recommended in the literature as a characteristic of an ecologically literate person, as well as for the research and practice of ICT in education. Systems thinking principally involves understanding phenomena based on the relationships existing within the components of a system, instead of trying to understand such components by examining them individually. According to the literature, systems thinking is an effective approach to address complex and unpredictable settings, such as the use of ICT for community education, which is also influenced by other dimensions of human society (e.g. socio-cultural dimension). So, in this study, systems thinking is not only an educational perspective that ought to be promoted in community members, but also an epistemological standpoint that drives the design and use of ICT for community EfS.

The fourth section of this literature review addressed the notion of Information and Communication Technology (ICT). The use of ICT in education is still emerging, with research and practice constantly evolving with ICT technological innovation. ICT features considered in this study are the use of Internet and of Internet websites for the dissemination of community EfS programs. Based on this, the ICT literature review included aspects related to the use of ICT in educational settings, as well as ICT-related theoretical considerations for the development of EfS websites aimed at the community level. In this section the concept of *affordance* was introduced, used in the ICT field to refer to all the possibilities that an ICT-based tool has to offer to an individual learner. In this respect, special attention is made in the literature in relation to the influence that an individual learner has over an ICT affordance, in the sense of the learner being the factor that ultimately shapes an affordance during its use. In addition, different types and concepts of affordance were presented, all aimed at providing ICT-related key ideas and considerations for the development of community EfS websites.

As the target audience of EfS websites are adults at the community level, Section 2.5 of this chapter reviewed aspects related to community education, adult education, and free-choice learning. This is because the

type of education that occurs through an EfS website aimed at the community level has characteristics of non-formal community education. Such education occurs outside formal educational institutions, but involves explicit and systematically organized learning approaches and goals. Moreover, the use of EfS websites by community members is self-directed and dependent on individual needs, as with other free-choice learning settings.

Another key aspect of community education is that a community constitutes a *broad audience*, including a range of existing conceptions over sustainability issues. This calls for the consideration of making an EfS website relevant for such a broad audience, for which understanding of the range of existing conceptions is crucial. Finally, social interaction within community members is regarded as a key condition to both social learning and social transformation towards ecological sustainability. From a systems thinking perspective, social interaction is believed to be the basis of healthy educational systems; and within ICT, it is said that Web 2.0 affordances can promote the interaction between community members by digital means.

The ideas and concepts addressed in this chapter, in relation to the use of EfS websites to promote socio-ecological sustainability at the community level were integrated into a theoretical model to be presented in Chapter 3. Many theoretical ideas and considerations from the literature are believed to be of assistance for the development of EfS websites for community education. In this regard, throughout this literature review key concepts were highlighted and summarised into tables. These tables contained the backbone, or theoretical structure that informed the development of theoretical model. The next chapter introduces the theoretical model for the development of EfS websites at the community level.

CHAPTER 3 - A THEORETICAL MODEL FOR THE DEVELOPMENT OF EFS WEBSITES

3.1 Introduction

This chapter presents a theoretical model for the design and development of EfS websites at the community level. This model is based on the literature presented in the previous chapter. As argued in that literature review, the main premise driving this theoretical model is that socio-ecological sustainability issues and challenges affecting local communities can be addressed through EfS interventions using ICT tools. The principal objective of EfS websites is to promote understanding and action around socio-ecological sustainability issues at the community level, and to promote sustainable living principles and practices among community members.

The first part of this chapter includes theoretical considerations from education for sustainability (EfS), systems thinking, Information and Communication Technology (ICT), and community education, in relation to learning approaches and website design considerations recommended in the literature. The second part of this model focuses on the process of designing an EfS website. This includes a planning phase where the conditions of the target community are assessed; a pre-design research phase where the objective is to achieve an understanding of the local characteristics and needs of the target community; and finally, the design phase that integrates theoretical aspects from the literature with practical aspects from the pre-design research phase, into the development of an EfS website.

As the theoretical foundations of the model have already been reviewed and discussed in previous sections of this chapter, the presentation of this model does not include a detailed review of its components. Rather, this section aims to highlight theoretical crossovers between the different areas of knowledge addressed in this review, in regard to the design and development of EfS websites for community education. Nevertheless,

reference to the sections where the components of this model were discussed more thoroughly is made when appropriate. These theoretical components and ideas now follow.

3.2 Theoretical considerations

This section presents the different theoretical considerations related to the educational context and setting associated with the use of EfS websites at the community level. Before engaging with the details of the theoretical model, Figure 3.1 represents in a graphical way the different theoretical considerations from the areas reviewed in Chapter 2 coming together and merging into a model for the design of EfS websites.

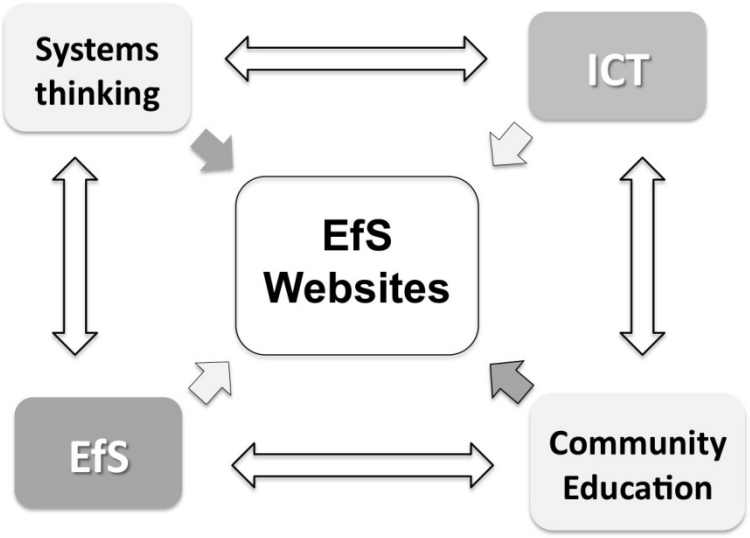

Figure 3.1. Representation of the theoretical crossovers between EfS, ICT, systems thinking and community education informing the model for developing EfS websites.

The first aspect to recognise is that the educational contexts for which an EfS website is designed are characterised by types of learning related to adult education and community education. As reviewed in Section 2.5.1, education at the community level encompasses types of learning processes that are principally self-directed, and driven by an individual's needs and motivations (Brookfield, 1986; Chobot & Chobot, 1990). Such learning can be associated with free-choice settings, where the learner is

the one who chooses how, when and what to learn (Falk & Dierking, 2002; Galbraith, 1990a; McNair, 2006). The literature emphasises that learning processes at the community level are dependent on social interaction and communication (Boyer & Roth, 2005; Brookfield, 1990; Hugo, 2002; Krasny & Roth, 2010; Webler et al., 1995). In the view of systems thinking and complexity in education, learning emerges from the 'coupling' and interaction between learning actors (e.g. community members) (Jorg, 2000; Sumara & Davis, 1997).

On the other hand, according to literature from complexity theory in education, the role of an EfS website in such an educational context should be to act as an educational facilitator and leader (Morrison, 2002). This not only involves being an enabling and empowering factor towards socio-ecological sustainability, as reviewed in Section 2.3.2, but also, for example, to provide the means for learning actors to interact and affect each other, in order to create and facilitate a collective learning system (Davis & Sumara, 2005).

These and other characteristics of the educational context associated with the use of EfS websites for community education are shown in Table 3.1, which represents the integration of literature from across the range of areas discussed in the literature review (Chapter 2). The characteristics of the educational context, and the systems thinking focus and approaches to address such an educational context through an EfS website shown in Table 3.1, represent the context and approach of use of such an EfS website aimed at facilitating the learning process. Such a view should drive the design, development and type of use of EfS websites at the community level.

Table 3.1. Characteristics of community-based educational settings, and approaches from systems thinking for educational settings.

Characteristics of community-based educational settings (Section 2.5)	
Social interaction	Social interaction is regarded as a key condition for both social learning and social transformation
Transformative process	Community education involves emphasis on transformative processes
Active participation	Community education involves active participation and involvement on the part of community members
Real-life, local context and relevance	Community education deals mainly with a community's needs, problems and issues, involving immediate, relevant and locally-rooted issues
Free-choice learning	Community education offers free-choice learning contexts, characterized by self directed, voluntary, and depending on an individual's needs
Broad audience	Community educational interventions deal with broad audiences, which demand a wide range of variety, intensity and sophistication of interventions. This also calls for attention of the larger social context of the target community
Systems thinking in educational settings (Section 2.3)	
Learning context	Notion of the importance of the learning environment for the promotion of meaningful experiences for learners
Coupling and Interaction	Concept of 'coupling' and interaction between learning actors with 'learning' occurring as an emergent property
Creation and Nurture	Concept of promoting the creation and nurturing of educational systems as a way to facilitate the learning process
Leadership / facilitator	Educational systems regarded as *leaders* and *facilitators* that enable learning and empower learners

In terms of the EfS website, the main approach from systems thinking and complexity theory in education is that the website has to operate as an educational facilitator that enables learning and empowers learners (Morrison, 2002). In addition, as a facilitator the EfS website also needs to provide the conditions for the creation and nurturing of the educational systems where it operates, and for the promotion of coupling and interaction between learning actors (i.e. the EfS website and community members regarded as learning actors).

In relation to key factors to promote the creation and nurture of educational systems, as well as the coupling and interaction between learning actors to facilitate the emergence of learning, the literature recommends the following key conditions: promote means for the components of the educational system to affect each other (enhance interactivity), provide familiarity with the learning issue by effectively addressing the learning context, provide mechanisms to prompt ideas to interact (i.e. social networking), promote diversity in general, and promote a decentralized type of control of the educational system (Davis & Sumara, 2005). Within such an educational framework, the main objective of an EfS website is to promote both understanding and action around socio-ecological sustainability issues at the community level.

Therefore, considering that community education involves types of free-choice learning and adult education contexts, characterised by being voluntary and based on individual motivations and needs, an EfS website should lead and facilitate the learning process related to understanding and taking action in relation to socio-ecological sustainability issues and challenges. The literature highlights a series of pedagogical considerations that may be of assistance for the use of EfS website at the community level. The coming subsection presents these pedagogical considerations and learning approaches for EfS websites.

3.2.1 Learning approaches and strategies for EfS websites

In essence, a community EfS website is an educational facilitator that addresses socio-ecological sustainability issues and challenges affecting the target community. Table 3.2 presents nine learning approaches highlighted in the literature from the areas of systems thinking, EfS, ICT and community education as important pedagogical components to consider for community-based EfS websites.

Table 3.2. Learning approaches for community-based EfS websites.

Learning approaches for EfS websites (source)	
Transformative learning	The idea to change, transform, and/or shift the actual paradigms of thinking that have led to current sustainability issues, to new ways of thinking towards strong sustainability (Section 2.2.3).
Systems thinking	The idea to focus on the relations and connections between the different dimensions of sustainability (i.e. environmental, social, and economic dimensions). Education is about systems, connections and patterns of sustainability issues, and to provide the big picture by relating particular sustainability issues with other issues and dimensions (Sections 2.2, 2.3 & 2.4).
Ecological literacy	The notion of understanding the underlying ecological principles of living communities, e.g. ecosystems, and to live accordingly as a means to operate towards strong sustainability (Sections 2.2.3 & 2.2.4).
Long-term thinking	The notion of meeting our own needs without compromising the needs of future generations (Section 2.2.2).
Ethics and values	The idea to adopt ethical principles and values in accordance with socio-ecological sustainability principles (Section 2.2).

Critical thinking	Education towards the ability to analyze and evaluate symptoms, root causes and connections of sustainability issues (Sections 2.2.4, 2.3.2 & 2.4.3).
Political literacy	Importance of democratic and decision-making skills, and participation from community members (Section 2.5.2).
Understanding (awareness)	The notion of being aware and to comprehend what are the (root) causes of sustainability issues and challenges. Education of concepts, knowledge and theory about sustainability issues (Sections 2.2.4 & 2.3.2).
Action (competence)	The notion of engaging with practical and targeted actions that will impact on sustainability (understanding needed). Education of hands-on, practice and action skills to address sustainability issues (Sections 2.2.4 & 2.3.2).

The first five learning approaches from Table 3.2 correspond to the five key dimensions found to encompass the concept of sustainability in the literature (see Section 2.2.3). As argued in Section 2.2, these five dimensions are the key concepts underpinning the educational objectives and outcomes of EfS at the community level. Therefore, these five key dimensions are required to be part of the pedagogical components and learning approaches of an EfS website.

Critical thinking and political literacy are recognised in the literature as key components of EfS (Huckle & Sterling, 1996; Orr, 2004; Sterling 2001). In the context of EfS websites, to promote critical thinking for learners is essential to enhance the understanding process associated with sustainability issues (Hofreiter et al., 2007; Nicolaou et al., 2009; Tilbury, 1995). Concerning political literacy, as discussed in Section 2.2.4, this pedagogical component aims to provide the ability to individuals and community members to participate at the political level of sustainability issues (Tilbury, 1995). Hence, both critical thinking and political literacy can empower community members in the resolution of sustainability issues at the societal level (Capra, 2005b; Gough, 1997; UNCED, 1992; UNESCO, 2006).

Regarding the last two learning approaches in Table 3.2, i.e. understanding and action competence, these two pedagogical components are the key EfS components to be promoted through EfS websites. Understanding of socio-ecological sustainability issues, based on ecological literacy, allow learners to comprehend the root causes of sustainability issues, and their relations to other issues and dimensions. And action competence is regarded in the literature as the component of EfS that can lead towards real improvement of sustainability issues (Bolstad, 2003b; Jensen & Schnack, 1997), and is therefore crucial to include as part of the learning objectives of EfS websites. Table 3.3 presents the nine learning components from Table 3.2 organized in three different stages related to the learning process associated with the use of EfS websites by community members.

Table 3.3. Learning approaches and process associated with community EfS websites.

<table>
<tr><th colspan="2">A ➡ B</th><th>➡ C</th></tr>
<tr><td colspan="2">Understanding (A+B)</td><td>Action (C)</td></tr>
<tr><td>(A) Awareness / Knowledge</td><td>(B) Ecological Understanding</td><td>(C) Action for Sustainability</td></tr>
<tr><td colspan="2">Transformative learning</td><td></td></tr>
<tr><td colspan="2">Critical thinking</td><td></td></tr>
<tr><td></td><td colspan="2">Systems thinking</td></tr>
<tr><td></td><td colspan="2">Ecological literacy</td></tr>
<tr><td></td><td colspan="2">Long-term thinking</td></tr>
<tr><td></td><td colspan="2">Political literacy</td></tr>
<tr><td></td><td colspan="2">Action competence</td></tr>
<tr><td colspan="3">Ethics and values</td></tr>
</table>

As represented in Table 3.3, the process of building ecological understanding and action competence in community members using EfS

websites starts from a determined level of awareness. This learning process associated with EfS websites aims to promote a thinking shift towards socio-ecological sustainability for learners. This is complemented by the promotion of critical thinking. It is believed in the literature that such a process can lead to knowledge building and ecological understanding of sustainability challenges on learners (see Section 2.2). Achieving an ecological understanding of sustainability issues implies that learners are able to engage with systems thinking, ecological literacy, long-term thinking, political literacy and action competence, which in turn can lead to action for sustainability, and adoption of sustainable living principles. In addition, it is also recognised that such a learning process needs to be underpinned within ethical values and principles that are in line with socio-ecological sustainability throughout all three learning stages.

Along with these learning approaches that are foundational pedagogical components of EfS websites, literature reviewed in previous sections of Chapter 2 also provides learning strategies that can be of assistance to bring about the learning process described in Table 3.3 for learners. Six learning strategies were identified in the literature from systems thinking, EfS, ICT, and community education. Table 3.4 presents these learning strategies.

As discussed in previous sections of this literature review, each one of the six learning strategies from Table 3.4 can support the learning process described in Table 3.3 for community members. For example, addressing the emotional domain for learners, and including relevant information through positive communication, can potentially influence the learners' experience and motivation to engage with subsequent stages of the learning process. In another example, Ballantyne & Packer (2005) note that to promote motivation on learners it is important to challenge their beliefs (i.e. personal constructs related to sustainability issues), and enhance their sustainability-related conceptions (Ballantyne & Packer, 2005).

Table 3.4 Learning strategies for EfS websites.

Learning strategies for EfS websites	
Emotional / affective domain	The importance of addressing emotions and the affective domain for learning. Development of affective dimension through relevance and real-life issues to promote awareness and meaningfulness (Sections 2.3.2 & 2.5.2).
Knowledge integration / inquiry	The idea to develop knowledge integration of related issues, and critical thinking around sustainability issues (Section 2.4.3).
Relevance	The importance of addressing authentic and real-life issues that are meaningful to the local community. Address community's needs, problems and issues (Sections 2.4.3 & 2.5.1).
Learner conceptions	The importance of understanding the range of possible conceptions held by learners about local sustainability issues (Sections 2.4.3 & 2.5).
Challenging beliefs	Challenging beliefs to help the adoption of new information through cognitive dissonance ('evidence, effects, efforts' approach) (Section 2.5.2).
Positive communication	The importance of adopting positive ways of communicating about sustainability issues and challenges (Section 2.5.2).

Based on the above, the set of learning approaches and strategies presented in Tables 3.2 and 3.4 respectively, are considered key pedagogical components of an EfS website, allowing it to function as an EfS educational facilitator at the community level. Such a set of learning approaches and strategies should be implemented during the design process of educational and pedagogical affordances of an EfS website. The next section reviews ICT-based EfS websites features and affordances that can incorporate the learning approaches and strategies presented here. This is in consideration of the characteristics of community-based educational settings presented in the first part of this

section, and of the systems thinking approaches to address these types of educational settings.

3.2.2 EfS website features and affordances design considerations

Considering the educational characteristics that EfS websites as educational facilitators should adopt to address the educational context determined by community-based education, and the learning approaches and strategies recommended in the literature to bring about EfS objectives and goals, this subsection presents EfS websites features and affordances through which such a range of theoretical considerations can be implemented. Four main types of website-related features were identified in ICT literature that can be of assistance for the development of affordances that can implement the set of pedagogical considerations reviewed earlier. Table 3.5 presents these four ICT-related EfS website theoretical design considerations.

Table 3.5. Key ICT-related features and considerations for the design of EfS websites affordances.

EfS websites affordances design considerations (Section 2.4)	
Multimedia affordances	The idea of using animations, videos, photos, and other multimedia features to enhance the affordances provided by websites.
Web 2.0	The use of Internet and Web 2.0 features to enhance interactivity and community networking.
General website affordances	The use of other affordances that are part of the design process of websites, i.e. user accessibility, structure organization, colour layout, etc.
Affordance maximisation	The idea to maximize the affordances offered by a website in order to provide a meaningful experience to users.

According to Table 3.5, EfS websites can offer a range of types of affordances to learners. These principally involve three types of affordances: multimedia affordances; Web 2.0 and social media

affordances; and general types of affordances related to the design process of Internet websites, e.g. user accessibility based on the structure of a website. Multimedia affordances relates to the integration of two or more types of media (e.g. audio and text) into one particular format to present information on an EfS website. Examples of these are the use of animations, videos, photos, and/or audio to deliver information. Multimedia affordances can be designed in such a way that they can incorporate learning approaches and strategies, while addressing the characteristics of community-based educational settings. According to the literature, multimedia affordances can assist and enhance the learning process based on ICT tools, such as EfS websites (Mayer & Moreno, 2002; Sangin et al., 2008; Webb, 2005; Woo, 2009).

In addition, literature from ICT points out that Web 2.0 and social media related affordances can enhance interactivity and interaction among community members through social networking instances (Greenhow et al., 2009; Ravenscroft, 2009). From a systems thinking perspective, such interaction and interactivity between learning actors can promote the emergence of learning (Jorg, 2000; Sumara & Davis, 1997). This view involves the EfS website acting as an educational facilitator, and community members acting as learners.

Concerning the third type of website-related affordances, these are influenced and determined by the set of design-related decisions made during the development process of EfS websites. Every design decision, whether made consciously or not, influences the final quality of an affordance, and of the EfS website as a whole.

Finally, the fourth aspect related to ICT-based affordances for EfS websites from Table 3.5 is the concept of affordance maximisation. This concept simply relates to the idea of maximising learners' experiences from the use of an EfS website. This is by increasing the degree of perceptual information provided by an affordance (i.e. clarity of information); and by simplifying the degree of complexity associated with

undertaking and affordance (see Figure 2.6, Section 2.4.3) (McGrenere & Ho, 2000). ICT literature argues that the combination (and maximisation) of different types of affordances can enhance the learning process related to ICT-based learning experiences (Caladine, 2008; Greenhow et al., 2009; Pachler & Daly, 2009; Ravenscroft, 2009; Roschelle et al., 2000).

One important consideration related to the affordance concept in ICT is that opportunities offered to learners through ICT-based affordances do not necessarily imply that they will be relevant and/or meaningful to individual learners. Literature emphasises that it is not ICT technology per se that determines if an affordance is useful or not, but the users of such affordances (Dohn, 2009; Webb, 2005; Woo, 2009). This calls for attention to the particular socio-cultural characteristics and needs of the target community when designing ICT-based affordances for EfS websites. The following subsection addresses this aspect in more detail.

Another more overarching aspect to mention before engaging with the next subsection is that literature recommends ICT training for EfS educators. This is as a way to further enhance the learning process and affordances design of EfS websites (Aivazidis et al., 2006). Having said that, the next subsection presents design aspects related to the characteristics and needs of the target audience of EfS websites.

3.2.3 Target community characteristics and needs

This section presents EfS website design considerations related to the socio-cultural and educational characteristics and needs of the target community. The importance of this aspect during the design of EfS websites is that it allows the design team to develop culturally meaningful affordances and learning experiences. Table 3.6 presents a range of theoretical considerations from ICT and community education literature aimed at designing meaningful, relevant, and context-based EfS websites.

Table 3.6. EfS website design considerations to address the socio-cultural characteristics and needs of the target community (see Sections 2.4 & 2.5).

Addressing socio-cultural characteristics and needs	
Social and cultural context	The notion of clearly defining and addressing the target culture, social context, and the community's characteristics and EfS needs.
User-informed design	The idea of involving end-users in the design process of EfS websites to include end-users perspectives, and avoid design misinterpretations.
Learners conceptions	The importance of understanding the range of alternative conceptions held by learners.
Testing of pilot	To ensure target culture is addressed and to assess if desired outcomes appear.
Networking and Partnership	The importance of networking and establishing partnerships with local communities and strategic individuals and organizations.

The first three aspects from Table 3.6 are related to types of socio-cultural considerations regarding the target audience of an EfS website. Understanding the target culture requires a pre-design data collection phase. For example, interviewing local members and strategic individuals, or carrying out questionnaire surveys in public areas of the target community are methods that allow a comprehension of the socio-cultural characteristics of a place. More aspects related to methodological issues are further discussed in the next subsection, in relation to the design process of EfS websites, and in Chapter 4, in relation to the methodology of the present study.

Another way to achieve an understanding of local characteristics and needs is by involving local members in the design process of EfS websites. As discussed in Section 2.4.3, there are different types of involvement of local users in the design process of ICT-based educational

materials (Facer & Williamson, 2004). The selection of a particular type will depend on the logistics of the design process.

In regard to the notion of understanding the range of alternative conceptions held by local members about a particular sustainability issue, literature from EfS stresses the importance of this in that such understanding allows for actively addressing alternative conceptions through relevant educational affordances, which is said can enhance the learning process for learners (Ballantyne & Packer, 2005; Chu & Martinson, 2003; Menzel & Bögeholz, 2008). One example in the context of the design of an EfS website is that by identifying a common alternative conception in the target community regarding a particular socio-ecological sustainability issue, multimedia affordances can de designed specifically to address such alternative concept (e.g. through an educational video), or could be addressed by including a question and answer section as part of such an EfS website.

Finally, the trial and testing of a pilot EfS website is recommended in order to identify misinterpretations during the design process, and to evaluate its impact on end-users (Facer & Williamson, 2004; Linn et al., 2003). Moreover, literature also stresses the importance of networking and partnership with local individuals and organizations to facilitate the understanding of the local context, the design process of meaningful affordances, and for the promotion and penetration of the EfS website at the local level (Facer & Williamson, 2004; Monroe et al., 2007; Nomura, 2004; Thompson, 2002).

In this section, a range of theoretical considerations for the design of EfS websites about systems thinking, EfS, ICT, and community education was presented. These theoretical considerations pointed to three general theoretical aspects of the design of EfS websites: learning approaches and strategies; EfS websites features and affordances; and socio-cultural considerations for the development of meaningful and culturally relevant EfS websites. In addition, the characteristics of community-based

educational settings, and the characteristics of EfS websites as educational facilitators operating in such contexts were presented at the start of the section. As mentioned before, it is believed here that the range of theoretical considerations presented in this section can be implemented in an EfS website during its design and development.

The coming section introduces practical aspects and perspectives for the development of EfS websites.

3.3 EfS website design process

This section introduces practical aspects related to the design process of EfS websites. Based on the theoretical aspects presented in the previous section, and on literature from community education reviewed in Section 2.5.2, the development process of EfS websites has been organised into three consecutive phases:

- Planning phase
- Pre-design research phase
- EfS website design phase

As mentioned earlier in this chapter, the design process of an EfS website needs to be grounded on theoretical components, as well as on data collected during the pre-design phase. During the planning phase the objective is to assess the context of the target community, of the local socio-ecological sustainability issues, and to plan the logistics of the research phase and the design phase. Once this phase has been addressed, the research phase aims to achieve a deep understanding of the characteristics and needs of the target audience, and of the existing sustainability issues. And finally, the design phase combines key outcomes of the research phase with theoretical considerations in order to engage with the design and development of an EfS website. The following subsections provide further details of these design-related phases.

3.3.1 Planning phase

This early stage of the development of an EfS website involves defining a target community, and/or a sustainability issue to be addressed. In both cases, the aim is to develop an EfS website for a particular community for which such EfS intervention would potentially be relevant and meaningful, in educational and socio-ecological sustainability terms. On the other hand, the chosen community has to possess an adequate ICT infrastructure for the use of websites for EfS. This means, community members, in general terms, must have access to Internet and computers where they can access the EfS website. One issue with Internet access is that the faster/better 'information transfer' rate of an Internet connection, the better for the maximization of the affordances offered by multimedia and Web 2.0 features.

The above issues indicate that the selection of the target community depends on three main conditions. The target community has to be affected by one or more socio-ecological sustainability issues; there has to be an evident need and potential for the provision of an EfS intervention through an EfS website; and the target community has to possess an adequate ICT infrastructure and Internet penetration. In essence, as long as these three conditions are present, any community can be a potential target community for the use of EfS websites.

Another aspect of the early design stage is that it should include ICT training for the involved EfS educator(s). This is any kind of ICT training that may be needed to further enhance the learning process that can occur through the use of EfS websites.

Once the target community has been selected and complies with the three conditions for the use of EfS websites at the community level, and once EfS educators receive needed ICT training, the design process of an EfS website can move on to the next phase.

3.3.2 Pre-design research phase

This phase implies a research and data collection process regarding the target community, as a means to retrieve all the relevant information for the development, design, implementation, and use of EfS websites in the local context. This involves investigating the local, social, cultural, and ecological characteristics and needs of the target community. In addition, a review and evaluation of already existing EfS websites (or similar websites if EfS websites are non-existent, in terms of the present theoretical model) is needed in order to understand the actual use of EfS websites within the target community.

Besides interviews, surveys and observations that the researcher / EfS educator may carry out with the target community seeking to understand the local context, it is important to consider at least three other sources of information:

- The literature (if existent);
- A panel of (local) experts who are knowledgeable on different aspects related to the target community and the sustainability issue being addressed;
- Community members, who are the end-users of the EfS website (i.e. user-informed design).

Another important aspect of this phase is the assessment and understanding of the range of possible alternative conceptions existing within local community members, in relation to the chosen sustainability issue. Methods such as interviews and questionnaire surveys are good ways to assess the range of existing alternative conceptions. The identification of such alternative conceptions allows during the design phase to challenge learners' possible existing alternative conceptions and beliefs regarding local sustainability issues.

Regarding the review and evaluation of existing EfS websites already available to the target community (which may or may not be related to the chosen sustainability issue), this process permits to understand what is

the reality of the use of EfS websites in the target community, and what are the characteristics of the existing EfS websites that are meaningful to the target community. In other words, to know what are community members' preferences regarding website features, which may assist the design process of an EfS website. It can be noted that the review and evaluation of existing websites available to the target community can be regarded as part of the research process of the local, social, and cultural contexts and needs of the target community.

In another aspect of this pre-design research phase, networking and partnerships with local and strategic individuals and organizations (i.e. such as community groups, NGOs, etc.) are important. This can be crucial in the process of maximizing the outcomes of the design, development, implementation and use of an EfS website, as well as for the understanding of the local, social, and cultural contexts and needs of the target community.

In summary, this second phase of the development of an EfS website is about the assessment and understanding of the local contexts and needs of the target community. Once the information from this pre-design phase is available, and an understanding of the local socio-ecological context is evident, the design process of an EfS website can move into the last phase.

3.3.3 Design phase

The focus of this third phase is to design, develop, build, and finally publish an EfS website, which includes pilot tests of the website, commonly with end-users. This design phase is based on the theoretical considerations presented in Section 2.6.1, and on the information and data collected during the pre-design research phase. The final objective of this phase is to develop a culturally-meaningful and locally-relevant EfS website for the target community. In addition, this phase involves the setup of a design team, which ideally should be constituted of at least web design professionals (i.e. including graphic designers, photographers, and

multimedia developers), members of the local community acting as user-informed consultants as well as local experts, and one or more EfS educators. This design team needs to combine and integrate different types of information (i.e. theoretical and collected information), in order to define a guiding framework for the development of the core structure of the EfS website, and develop website affordances informed by such a framework.

It is expected that web designers and developers and EfS educators take the initiative in the type of structural organization of the EfS website, in terms of ICT affordances and EfS affordances respectively. Once a general structure and backbone pattern has been defined, in terms of the components and content of each section of the EfS website, the web team can move on to retrieve, develop and organise all the necessary information needed for each section of the website. This may include information about local sustainability issues, texts, photos, videos, animations, and all other affordances that can be implemented on an EfS website. This process should receive constant input from local community members of the design team, in terms of achieving local relevance. In addition, as part of the development of such affordances, the design team should evaluate the best way to integrate theoretical considerations, and contextual information, on the development of the EfS website's affordances.

In regard to the development of Web 2.0 affordances, it is recommended to incorporate a subsidiary system of social media websites into the EfS website. In practical terms this means creating accounts and profiles in the most relevant social media types of Web 2.0 tools and services available in the target community (e.g. Facebook, Twitter, Instagram, YouTube). The objective of such a system of subsidiary Web 2.0 websites is to support and complement the EfS website in terms of Web 2.0 affordances, and to go where potential users are. Two considerations are: to constantly maintain and update the system of Web 2.0 websites; and related to this,

to avoid repetition of information between the system of Web 2.0 websites and the EfS website.

In addition, as Web 2.0 websites usually can be administered by one or more individuals, it is important to define Web 2.0 administrators of an EfS website whose objective is to keep Web 2.0 websites updated, and to interact with community members. Social media administrators require a good understanding of the objective and purpose of the present theoretical model and associated theoretical background. Similarly, it is crucial that Web 2.0 and social media administrators originally come from the target community, or at least have a sound understanding of the socio-ecological context, in order to promote and enhance the meaningfulness and relevance that can be achieved through such Web 2.0 affordances.

In another aspect, as the target community may include a broad audience, the consideration of a wide range of possible affordances is recommended. This principally includes a diverse range of information and sophistication of information regarding the different topics addressed in the EfS website. The objective of this is to reach as many learners as possible, by offering a range of different affordances to such a broad audience.

In terms of the testing of a pilot version of the EfS website, once the design team has developed a first version of the EfS website, it is important to trial it and assess against the desired outcomes. To achieve this, pilot testing among a group of local community members is necessary, including an evaluation of the input and feedback that members from the testing group can provide. Based on such an evaluation, corrections and improvements can be made to the EfS website in order to enhance its overall affordances through new versions of the EfS website. Finally, when the last version satisfies the design team, the EfS website can be published online for its use by community members. An important aspect of this final stage of the design and development of an EfS website is that a marketing process of the website is recommended

in order to inform local community members about the existence of the EfS website. One good option for such marketing is to use local news media and publish press releases through local newspapers and radio. Another option is to organise seminars and/or public events around the local community to present the EfS website to community members and relevant organisations, and to answer questions that the general public may have in regard to the website.

Finally, it is important in EfS practice to always include an evaluation phase of EfS interventions. The impact and outcomes of the use of an EfS website at the community level should regularly be evaluated in order to make corrections and improvements, as well as to adapt the website to new conditions that may appear within the learning context that may influence the operation of the EfS website as an educational facilitator. Such an adaptive process can be related to the concept of self-nurturing educational systems, in the sense of making educational facilitators always relevant and meaningful to the local conditions of the educational setting.

The issues presented and discussed in this section are guiding principles for the development of community-based EfS websites. At this stage this model is based on theoretical considerations from the literature, and needs to be trialled and tested in a real life context. This is to assess and evaluate its real effectiveness for the design, development, and use of EfS websites for community education for sustainability. Chapter 5 of this thesis provides insights into the application of this theoretical model in a real life context, in relation to the intervention setting of this study.

3.4 Summary

This chapter presented a theoretical model for the design and development of EfS websites for community education. This model is based on theoretical considerations and principles reviewed in the literature review. In terms of the present study, this model was used as part of the intervention of this study, and evaluated in the context of a real-

life socio-ecological sustainability issue affecting the target community of this study. More detail of the trial and evaluation of this theoretical model follow in Chapter 5. Findings and outcomes of the use of an EfS website in the target community are then presented in Chapters 6, 7 and 8. Finally, the conclusions, limitations and implications of this theoretical model are further discussed in Chapter 9.

The next chapter presents the methodology that underpinned the research design of this study and how data was gathered and analysed to respond to the research questions.

CHAPTER 4 - METHODOLOGY

4.1 Introduction

This chapter presents the methodology adopted in this study to investigate the use of ICT for EfS at the community level. In the first part of the chapter, the research questions guiding this study are presented, and the methodology and methods adopted to address such research questions are introduced. Then follows the research design and data collection phases describing the context in which such methodology and methods were applied. Finally, the last part of the chapter focuses on the analytical procedures selected to evaluate the data collected during the intervention of this study. This includes accounts in relation to the trustworthiness of data collected, and the ethical considerations adopted as part of this research.

4.2 Research questions

As indicated in the introductory chapter of this thesis, the aim of the present research was to understand the effective use of ICT to enhance education for sustainability (EfS) at the community level. In particular, the objective was to evaluate the use of EfS websites for the promotion of understanding of sustainability issues and action for socio-ecological sustainability among local community members of the target community in Chile. The research questions are what guided the selection of a study methodology, a set of methods for data collection, and the research design. This study is driven by the following main research question, and set of four related sub-questions supporting the main research question:

Research question:

> Can the use of websites assist non-formal education for community understanding of sustainability issues in Chile?

Research sub-questions:

- What ideas could be used to design an EfS website to promote understanding and action for sustainability at the community level?
- How do community members use an EfS website and what for?
- Does the use of an EfS website improve understanding of sustainability issues amongst community members?
- Does the use of an EfS website promote action, and adoption of sustainable living principles among community members?

The principal goal of this study was to address these research questions. In order to address the main research question, the set of four sub-questions needed to be evaluated first, as they inform the main question. The first sub-question, related to theoretical considerations and ideas, was addressed through the identification of key considerations present in the literature that informed the theoretical model presented in Chapter 3. Based on this model, during the intervention of this study an EfS website was designed (see Chapter 5) to serve as the research instrument to address the remaining three sub-questions.

The second sub-question aimed to understand the type of use of an EfS website by community members (i.e. the 'how' of the use of an EfS website by community members), and the purpose of use of the website (i.e. the 'what for' of the type of use). The last two sub-questions evaluated if the use of such an EfS website can promote understanding, and action, around local sustainability issues affecting the target community. By addressing these research questions, an understanding of the effective use of Internet websites to assist community EfS in Chile was aimed to be achieved, including the characteristics and different aspects associated with such an educational process. In the next section, the methodology adopted in this study is presented.

4.3 Methodology

This section presents a review of different inquiry paradigms and research traditions within the field of educational research. Arguably, four different

main paradigms can be found today in educational research literature: positivism, naturalism, critical theory, and complexity theory (Cohen, Manion & Morrison, 2007). This section presents the key characteristics of each one of these research traditions, with arguments providing the reasons to embrace or dismiss them within the focus of the present research. In the last part of the section the case is made for the adoption of a naturalistic and interpretive paradigm for the investigation of the use of ICT for community EfS. Note that other scholars in the field recognize and group the existing paradigms in different ways, however, the above distinction made by Cohen, Manion & Morrison (2007) is the one guiding this section. Nevertheless, some other views regarding inquiry paradigms for educational research are also indicated.

The first point to address is to define a methodology and a paradigm within educational research are. Somekh and Lewin (2005) define methodology as a collection of principles, theories and rules (or methods) that frame the approach to a particular research study, whereas Mackenzie and Knipe (2006) stress that the most common definitions of methodology focus on the overall approach to research linked to a paradigm or theoretical framework. In turn, a paradigm is often defined within the literature as a collection of basic beliefs or worldviews that guide the researcher by providing the perspective to choose the methods of inquiry, “but in ontologically and epistemologically fundamental ways” (Guba & Lincoln, 1994, p. 105; Lincoln & Guba, 1985; Patton, 2002). Furthermore, Guba and Lincoln (1994) argue that such a set of basic beliefs can be determined and summarised based on the three fundamental questions related to the ontology, epistemology, and methodology of paradigms (p. 108). These questions are:

1. *Ontology*: What is the form of nature of reality, and what is there that can be known about it?
2. *Epistemology*: What is the nature of the relationship between knower and what can be known?
3. *Methodology*: How can the inquirer go about finding out, whatever he/she believes can be known?

In summary, a research paradigm and methodology work together with the research questions to form a research study, both by influencing the way knowledge is studied and interpreted, and by defining the subsequent choices of methods, literature, and research design underpinning the study (Cohen, Manion & Morrison, 2011; Mackenzie & Knipe, 2006; Mertens, 2005).

In general terms, historically two main paradigms in educational research were recognized, each one with its own set of assumptions and strategies: the “classical” or positivistic tradition, and its contrasting counterpart initially called the “social anthropology” paradigm (Parlett & Hamilton, 1972, pp. 2-3), also known as the naturalistic paradigm (Lincoln & Guba, 1985). More recently, a growing number of theoretical paradigms can be found within the educational research literature, such as: positivist (and postpositivist), constructivist, interpretivist, transformative, emancipatory, critical, feminist, pragmatism and deconstructivist paradigms (Mackenzie & Knipe, 2006; Morrison, 2002). Concerning the proliferation of paradigms, Guba and Lincoln in 1994 argued that, excepting the positivistic paradigm, the other paradigms within educational research were still in a formative phase; and that some of the paradigms listed above could be grouped under what is known today as critical theory (e.g. Marxism, feminism and participatory inquiry) (Guba & Lincoln, 1994). More recently, and as mentioned earlier, Cohen, Manion and Morrison (2007) have classified four paradigms in educational research, these being:

- Positivism
- Naturalism
- Critical theory
- Complexity theory

In the following sections, a brief presentation of each one of the four paradigms identified by Cohen, Manion and Morrison (2007) follow, with the last section further developing the naturalistic paradigm as the philosophical framework chosen to address the research questions of the present study.

4.3.1 Positivism

The positivistic paradigm, although recurrent in the western tradition from the Ancient Greeks to the present days, is recognized to have its origins in the nineteenth century French Philosopher Auguste Comte; and was further developed by the Vienna Circle in Austria and the Berlin School in Germany during the early 20th century (Cohen et al., 2007; Mackenzie & Knipe, 2006; Patton, 2002). The positivistic worldview asserts that only direct and verifiable experience constitutes genuine knowledge (Patton, 2002). The ontological position of positivism is that an "apprehendable reality is assumed to exist", where the researcher and the researched object are assumed to be independent (i.e. dualist and objectivist), and knowledge can be conventionally summarized as being "time-, and context-free" (Guba & Lincoln, 1994, p. 109). Positivism is linked to scientific knowledge and scientific method, where the ultimate 'truth' of reality is seen to be reached through empirical and manipulative experimental methodology evaluating propositional hypotheses (Guba & Lincoln, 1994; Mertens, 2005). The view within the positivistic paradigm is that only a rigorous and systematic methodology, based on quantitative and value-free data, can provide reliable and valid knowledge (Denzin, Lincoln & Giardina, 2006).

From a social science point of view, there are many aspects of the positivistic paradigm that lead me to dismiss it for the purpose of the present research study. For example, manipulative experiments of positivism disregard the variables not accounted for empirical research, assuming that such 'stripped' variables do not affect the ultimate validity of knowledge attained (Guba & Lincoln, 1994). Positivism ignores the contexts of social experience, and excludes the meaning and purposes of human behavior (Denzin et al., 2006; Lincoln & Guba, 1985). Similarly, predictability and generalization of positivistic epistemology disregards the particularities of individual cases; as well as assuming it is possible to separate the observer from the observed (Guba & Lincoln, 1994).

In summary, the ontological and epistemological assumptions of positivism, although successful within the natural and biomedical sciences, have been the main points of criticism from anti-positivists. The mechanistic and reductionist view of nature that defines life in an objective and measurable way, excluding notions of “choice, freedom, individuality, and moral responsibility”, are what dismisses positivism in general as a research paradigm from the view of social sciences (Cohen et al., 2007, p. 17); and in particular for the purposes of the present study.

4.3.2 Naturalism

As a contrasting alternative to the objective and dualist nature of positivism, the naturalistic paradigm emerged as an anti-positivistic movement (Lincoln & Guba, 1985; Parlett & Hamilton, 1972). The ontological position of naturalism is that “there are multiple constructed realities”, making control and prediction unlikely as inquiries into these different realities may inevitably diverge (Lincoln & Guba, 1985, p. 37). In this sense, anti-positivists would argue that understanding individuals’ behavior is only possible when the researcher shares their frame of reference, making the inquiry subjective, i.e. the knower and the known are inseparable (epistemological view of naturalism) (Bogdan & Biklen, 1992; Patton, 2002). The term ‘naturalism’ itself represents a contrasting view to positivism, as the principal source of data is the unaltered *natural setting* of phenomena, compared to positivism where the source of data comes from manipulated and context-free settings (Cohen et al., 2011). The underlying principle of naturalism is that realities as a whole cannot be understood in isolation of their milieu, making data context-bound (Lincoln & Guba, 1985). As highlighted by Patton (2002), the context of inquiry is “critical to understanding” (p. 63).

One of the characteristics of the naturalistic paradigm is its interpretivist aspect. The researcher understands the human and social world based on the accounts and views of participants (subjects of study), making sense of such accounts by interpreting them (Cohen et al., 2007). The interpretive researcher relies on the views of participants, recognizing the

impact of their own background and experiences in this process (Creswell, 2003; Mackenzie & Knipe, 2006). It is precisely such interpretation of participants' perspectives as the source of knowledge, which is the principal point of critique of this paradigm from positivism. The view of positivists regarding the naturalistic paradigm is that such an approach is inaccurate, incomplete and misleading; does not allow generalization of human behavior; and does not account for false reports and/or others' influence on participants' reports (Argyle, 1978; Bernstein, 1974; Cohen et al., 2007). Other criticisms of the naturalistic paradigm, as well as of the positivistic paradigm, come from a range of post-structuralism and postmodernism alternative paradigms grouped under the term *critical theory* (Guba & Lincoln, 1994). The review of these now follow.

4.3.3 Critical theory

During the 1970-80s, a range of alternative paradigms emerged under the view that both dominant research paradigms, i.e. positivism and naturalism, were lacking accounts of social behavior by neglecting the full implications of a value-determined inquiry (Lincoln & Guba, 1985; Mertens, 2005; Patton, 2002). This is what Cohen et al. (2007) call the disregard of the political and ideological contexts of educational research. As stated by Lincoln and Guba (1985), in consideration that inquiry cannot be value free, inevitably "any given inquiry will necessarily serve *some* value agenda" (p. 9).

Such a set of alternative paradigms included neo-Marxism, feminism, materialism, queer theory, participatory inquiry, and other postmodernist and post-structuralism paradigms, which are grouped in the literature under the name of *critical theory* (Guba & Lincoln, 1994; Patton, 2002). The common point between these and other alternative paradigms was the search for the emancipation of individuals and groups into an egalitarian society (Fay, 1987).

In this sense critical theory is explicitly prescriptive and normative. It not only seeks to understand human behaviour and phenomena, but also to

realize a society that is non-discriminatory to its members. It neglects research that does not operate towards the general interest, social justice of the disempowered, and democratic freedom of members of society (Cohen et al., 2007; Somekh & Lewin, 2005). Put in other words, critical theory is a transformative paradigm (Mackenzie & Knipe, 2006). Transformative researchers felt that educational research should address issues of social justice and marginalized peoples, under the view that inquiry “needs to be intertwined with politics and a political agenda" to change and transform the lives of individuals and institutions (Creswell, 2003, p.9).

The ontological view of critical theory is that a reality is assumed to be comprehendible, but such reality is then shaped by social, political, cultural, economic, ethnic, and gender factors (Guba & Lincoln, 1994). Under such an ontological view, a methodology of the heart that embraces an ethics of truth that is “grounded in love, care, hope and forgiveness is needed” (Denzin et al., 2006, p. 770). Some criticisms of critical theory are that emancipation of society is not proven to necessarily come from an ideological critique; and that research based on a political agenda corrupts the task of the researchers, who ought to be dispassionate and disinterested instead of based on ideologies (Cohen et al., 2007). Reasons to dismiss such a paradigm in regard to the present study are discussed later. Before that, a brief look at the complexity theory paradigm follows.

4.3.4 Complexity theory

More recently, the “emerging fourth paradigm in educational research is that of complexity theory” (Cohen et al., 2007, p. 33). Both complexity theory and systems theory have appeared as a philosophical and methodological paradigm in educational research (Morrison, 2002). This approach is characterised by organic, non-linear and holistic perspectives, thus breaking with traditional cause-and-effect models, linear predictability, and reductionism of phenomena (Santonus, 1998; Morris & Martin, 2009). Complexity theory and systems thinking call for the consideration of the

whole rather than the *parts* (Morris & Martin, 2009; Sterling, 2001). The ontological standpoint is that the nature of being is complex (Morrison, 2002). For example, modern world problems are increasingly complex, and interdependent, and can no longer be understood in isolation and by taking them apart. Rather, a shift in perception is required to consider phenomena as being interconnected and integrated in a web of relationships with other factors and dimensions (Brown, 2008).

Within such complexity, where different elements interact dynamically, spontaneously, and unpredictably, complexity theory and systems thinking offer a useful way of explaining the events taking place (Morrison, 2002). The epistemological approach lies in the holistic understanding of the *relationships* existing between the different components of the system (Morris & Martin, 2009), and is premised on qualitative accounts (Capra, 2008). In addressing holism, educational research in complexity theory and systems thinking argue for methods of enquiry that are collaborative, interactionist and multi-perspectival (Cohen, et al., 2007).

One characteristic of complex phenomena is that emergence of new properties is spontaneous and self-organized (Corning, 2002; Goldstein, 1999). Emergence in complex systems is a result of the dynamic interaction between the elements of a system, and between the system and its environment (Morrison, 2002). Regarding the complexity theory and education, complexitivists recognize that learning is an event of emergence (Davis & Sumara, 2005); or as indicated by Jorg (2000), it is a dynamic and active process that occurs during the reciprocal interaction or *coupling* between learning actors. In summary, complexity theory in education not only represents a challenge to conventional educational research, it also provides an emerging new paradigm for research (Cohen et al., 2007).

4.3.5 Methodology chosen for this study

Having reviewed the four paradigms indicated by Cohen, Manion and Morrison (2007) as the main paradigms within educational research, it is

important to note that the categorization of educational inquiry paradigms based on these authors is arbitrary. Lincoln and Guba in 2000 identified five research paradigms: positivism, post-positivism, critical theory, constructivism, and participatory (Lincoln & Guba, 2000). Whereas, other authors identify other paradigms, for example, pragmatism, where researchers are not committed to a philosophical view, but rather focus on the 'what' and 'how' of inquiry (Mackenzie & Knipe, 2006). Patton (2002) captures the essence of the paradigm debate in educational research when stating "there is no definitive way to categorize the various philosophical and theoretical perspectives that have influenced and that distinguish types of [qualitative] inquiry" (p. 79).

From the perspective of the present study, the four paradigms presented here are relevant because, in one way or another, they are related to the present research. Positivism is at the very core of the scientific knowledge that permitted the technological development of ICT. Naturalism provides accounts of the learning process that occurs at the community level, under the view that knowledge is socially constructed. Elements of critical theory are intrinsically related to the purpose and objectives of EfS, like the promotion of a thinking shift towards socio-ecological sustainability at the societal level. Regarding complexity theory and systems thinking, these ontological worldviews are underpinning the design and use of ICT tools at the community level to promote such EfS goals.

As mentioned earlier, the selection of a particular research paradigm depends on the research questions to be addressed. In the case of the present study, for the investigation of the learning process related to the use of websites for community EfS, a naturalistic paradigm seems appropriate. This is because the ontological and epistemological standpoints of naturalistic inquiry fit the purposes of this study. In particular, constructivist and interpretive approaches from naturalistic inquiry were adopted to evaluate the learning process occurring among community members based on a socially-constructed EfS website regarded as an educational tool. Regarding complexity theory as a

potential paradigm for this study, complexity theory is said to overlook factors related to the historicity of systems, by only focusing on the here-and-now (Leadbetter, 2005), which does not fit aspects of this research, such as the importance of cultural and historical considerations when developing EfS websites. In the case of critical theory, this approach involves the adoption of a political agenda (Cohen et al., 2007), which is neither the intention nor the scope of this study.

As pointed out in the literature, the interpretivist/constructivist approach intends to understand "the world of human experience" (Cohen & Manion, 1994, p. 36), suggesting that reality is socially constructed (Mertens, 2005). Human beings have developed cognitive processes to interpret and construct their reality, with such reality being built and shaped based on cultural factors (Kelly, 1991; Piaget, 1955). Therefore, interpretivist/constructivist research focuses on the study of people's constructed realities that determine their lives (Patton, 2002); for which it relies on the "participants' views of the situation being studied" to achieve a 'thick' description (Creswell, 2003, p. 8). As mentioned in the Chapter 2, community members possess unique cognitive frameworks determined by their individual backgrounds, expectations, needs, and motivations, which influence the learning process (Brookfield, 1990; Menzel & Bögeholz, 2008). In turn, social interaction, as well as the social context of such interaction, are said to be at the basis of socially constructed learning (Sterling, 2005; Sumara & Davis, 1997; Webler et al., 1995).

The methodological approach of interpretivist/constructivist research is centred in the interaction and consented negotiation between the researcher and respondents (Guba & Lincoln, 1994). Methods such as open-ended interviews and observations are recommended for this process, and to capture the different perspectives of a particular phenomena existing within the individuals of a community, where attention to the context of social learning and research is critical (Patton, 2002). In summary, the interpretive and constructivist approaches of the naturalistic paradigm have been selected to address the research questions of this

study, related to the learning process occurring for community members using an EfS website. In turn, such a methodological approach defines the subsequent choice of methods and research design of this study. In the next section the methods used in this study are reviewed.

4.4 Methods

This section presents the research methods adopted in this study. A method is a procedure used or followed to accomplish a particular goal. In the present research, five different methods were chosen to address the research questions underpinning this study. The first part of the section discusses general aspects and issues related to the types and purposes of methods used in educational research. The second part of the section reviews the characteristics of the five methods used: questionnaire surveys, interviews, observations, document analysis, and use of Google Analytics tools. This last method is not directly linked to the evaluation of the learning process with community members based on the website, as the other four methods are, but is related to the quantification of the visits made to the EfS website during the intervention period. Such a method is based on the use of Google Analytics tools, an analytical service provided by Google Inc. (2012).

Educational research literature highlights two types of inquiry methods: quantitative methods and qualitative methods. Quantitative methods are characterized by dealing with numerical data, i.e. quantitative data. As historically there has been a great emphasis on quantification in the 'hard' sciences (e.g. Mathematics and Physics), quantitative methods are generally linked to positivistic traditions (Guba & Lincoln, 1994). On the other hand, qualitative methods are rather characterized by accounting for participants' subjective definitions of situations. This means that qualitative methods are appropriate to interpret, explain, and/or make sense of such types of sources of data (Cohen et al., 2007). Because of this, qualitative research methods are commonly associated with naturalistic and interpretive educational inquiry (Mackenzie & Knipe, 2006).

Despite the predominant distinction in the literature between positivism being more related to quantitative approaches, and naturalism operating under qualitative methods of inquiry (Cohen & Manion, 1994; Lincoln & Guba, 1985; Parlett & Hamilton, 1972), such a distinction is historically determined. It is recognized in educational literature that both quantitative and qualitative research methods can be appropriately used within any research paradigm (Guba & Lincoln, 1994; Patton, 2002). In this sense, Parlett and Hamilton (1972) highlighted that it is the problem, or the research question, which ultimately determines the selection of a particular method. In fact, many researchers point out that both qualitative and quantitative methods can be complementary (Cohen et al., 2011; Creswell, 2003; Patton, 2002; Thomas, 2003), with Mackenzie and Knipe (2006) stressing that “no one paradigm actually prescribes or prohibits the use of either methodological approach” (p. 201).

As described in the methodology section, the selection of a research method is intimately linked to the selection of a particular research paradigm and research methodology, which in turn is driven by the research questions of a study. In the case of the present research, a naturalistic inquiry paradigm has been adopted, with emphasis on constructivist and interpretivist approaches, to evaluate and understand the use of EfS websites for community education. Within such a research frame, qualitative methods of inquiry are recommended within the literature, although quantitative methods are also considered as being applicable in certain ways (Cohen et al., 2007; Denzin & Lincoln, 1994). But the common standpoint is that social phenomena need to be understood through the eyes of participants, where every individual constructs their own worldview of reality based on cultural factors. In this sense, qualitative methods of inquiry, such as questionnaires, interviews, and observations, contribute to the depth of understanding by providing detail of particular cases being studied; but reduce generalizability, this being regarded as a drawback from positivistic perspectives (Cohen et al, 2007; Lincoln & Guba, 1985; Patton, 2002).

The following sections present in detail the different methods of inquiry chosen for this study, and their use of quantitative and qualitative data.

4.4.1 Questionnaire surveys

Questionnaire surveys are a widely used type of research instrument that allows the collection of information in the form of structured data. The principal advantages of questionnaire surveys are that they can be administered without the presence of the researcher, and potentially to a large cohort; they are relatively straightforward to analyze; and a wide variety of types of data can be obtained through them, depending on their particular design (Frazer & Lawley, 2001; Wilson & McLean, 1994). In addition, they are particularly useful when investigating issues of prevalence, and to examine large-scale patterns in education (Desimone & Le Floch, 2004).

On the other hand, the main disadvantages are that: they can be time consuming in their design, preparation, and refinement; they can lead to data overload; they do not provide the depth of understanding that interviews and observations do; and their administration always represents an intrusion to participants' lives (Desimone & Le Floch, 2004; Parlett & Hamilton, 1972). This last factor may lead to untrustworthy accounts from participants, or simply determine the response rate. Another critical issue with questionnaire surveys is the construct validity of the research instrument. The quality of data is strongly dependent on the instrument design, in particular the issue regarding how similar are the researcher's constructs to those of participants, and how meaningful the survey instruments then are to participants (Cohen et al., 2007; Wilson & McLean, 1994). Section 4.6 of this chapter provides further insights regarding data validity and trustworthiness.

There are different types of questionnaire surveys: structured, semi-structured, and unstructured. There are also many types of questionnaire questions: open questions, closed questions, dichotomous questions, multiple choice questions, open-ended questions, and rating scales

questions among others (Cohen et al., 2007; Frazer & Lawley, 2001). The selection and use of a particular type of question, or of a particular set of types of questions, will directly depend on the purpose and objectives of the questionnaire survey, and on the research questions being addressed through the instrument. Other key considerations during the design of questionnaire surveys, apart from validity-related issues, are to avoid pitfalls in question writing, being particularly mindful when asking sensitive questions, and considering attractive layouts and organizational structure in an effort to obtain a good response rate (Cohen et al., 2007; Desimone & Le Floch, 2004).

In the present study, different questionnaire surveys were used throughout the data collection phases. The selection of this research instrument was based on the advantages provided by questionnaire surveys to describe demographically the participants of this study; identify patterns of recurrence and prevalence within participants' backgrounds (e.g. level of knowledge of the target sustainability issue); and that questionnaire surveys are relatively easy to administer, which in community-based educational study greatly contributes to the logistics of the data collection. More detail on the particularities of the different questionnaire survey instruments is discussed in the coming sections. All research instruments used in this research, including questionnaire surveys, can be found in the appendix.

4.4.2 Interviews

An interview is a purposeful conversation between the researcher and the respondent, where the purposes can include, among others, to obtain 'here-and-now' constructs from individuals, and the 'projections', 'reconstructions' and/or 'verifications' of such constructed entities (Lincoln & Guba, 1985). In other words, the purpose of interviews is to enter another person's perspective (Patton, 2002). As mentioned above, one advantage of interviews over questionnaire surveys is that they can provide "depth, detail, and meaning at a very personal level of

experience", contributing to the achievement of a deep understanding of personal constructs of respondents (Patton, 2002, p. 17).

Another advantage of interviews is that they allow the respondent to move back and forward in time. This is particularly so with unstructured interviews that can access the unique, idiosyncratic, and holistic viewpoint of the interviewee; in contrast, structured interviews seek information more in terms of the interviewer's framework (Lincoln & Guba, 1985). In both cases, nonetheless, the interview represents a flexible research tool for the researcher, as she/he can control it while still allowing for spontaneity, and respondents can be pressed for complete answers and/or about responses regarding complex and deep issues (Cohen et al., 2007)

An interview represents a relationship between the participants, i.e. both the interviewer and the interviewee are seen as participants, therefore the quality of the data obtained through an interview directly depends on the quality of such relationship (Patton, 2002). Related to this, Oakley (1981) raised some criticisms of the prescriptive nature of this method, arguing that the traditional approach of interviewing collected data from essentially passive informants from a set of pre-determined questions. She also stressed that the role of the interviewer ought to be of a debater, not of a recorder retrieving information from a knowledge-producing object, as in positivistic traditions. Instead, to enhance the relationship existing between the participants of the interview, the relationship between the interviewer and the interviewee needs to be non-hierarchical, with the interviewer prepared to engage with his/her own personal identity in the relationship (Bishop, 1997, p. 32; Oakley, 1981).

As with questionnaire surveys, there are different types of interviews, each one being more appropriate to different purposes and perspectives, and each one with its strengths and weaknesses. Cohen, Manion and Morrison (2007), echoing Patton (1980), recognize four main types of interviews in educational research. The characteristics, strengths, and weaknesses of these types of interviews are presented in Table 4.1.

Table 4.1. Characteristics of the four principal types of interviewing methods found in educational research (source: Patton, 1980).

Type of interview	Characteristics	Strengths	Weaknesses
Informal conversational interview	Questions emerge from the immediate context; are asked in the natural course of things; there is no predetermination of question topics	Increases the relevance of questions; interview is built on observations; and can match context circumstances	Different questions to different people can lead to difficult organization and analysis
Interview guide approach	Topics and issues covered are specified in advance	Outline increases comprehensiveness of data; logical gaps in data can be anticipated	Important and salient topics may be omitted; flexibility in layout can make comparative analysis difficult
Standardized open-ended interview	Exact wording and sequence of questions are predetermined	Increases comparability between respondents; reduces interviewer effects	Little flexibility in relating the interview to particular individual and circumstances
Closed quantitative interviews	Questions and responses are determined in advance; responses are fixed	Data analysis is simple; comparative analysis is straightforward;	Respondents must fit their experiences and feelings into the researcher's categories. Possible distortion of meaning

The type of interview depends research purposes and objectives of the interviews. A combination of different types of interviews is encouraged in order to enhance the collection process of data (Patton, 2002). In the context of the present research, interviews were carried out throughout the data collection phases, both in relation to the design and development of an EfS website, and for the investigation of the use of the website by community members in Chile. All four types of interviews described in Table 4.1 were adopted and used during this research, depending on the characteristics and objectives of each data collection phase. More detail on the use of interviews in the context of the present research is described later in this chapter, as well as in following chapters.

4.4.3 Observations

Observational methods of inquiry represent a powerful research tool for naturalistic researchers. The key advantage of observations is the depth of understanding that can be achieved while being in the natural field (Lincoln & Guba, 1985; Cohen et al., 2007). Observations as a research tool become potent when used for fairly long periods of time, as the researcher may be present at different yet related events that inform the research (Parlett & Hamilton, 1972). Observations allow the description of the setting from the researcher's perspective, providing first-hand experience with the dynamics of the setting. Moreover, the observer may catch and record events that can escape participants' perceptions by being immersed in a context-dependent routine, and which may be missing in data collected through questionnaires and/or interviews (Patton, 2002). In addition, in a similar way with interviews, observations are flexible and can vary in scope at different stages of a research study (Lincoln & Guba, 1985), allowing the observer to record and organize data on the go (Parlett & Hamilton, 1972).

As with questionnaire surveys and interviews, there are different approaches to carry out observations during educational research. Observations can be highly structured, semi-structured, or unstructured, depending on the degree and predisposition to 'look for' particular aspects,

events and/or situations in the research setting (Cohen et al., 2007; Patton, 2002). Highly structured observations will know what to look for, and will have the different categories of observations defined in advance. Whereas unstructured observations will be “far less clear on what it is looking for”, hence deciding what constitutes relevant evidence for the research after the observations were carried out (Cohen et al., 2007, p. 397). In addition, there are degrees of researcher participation in observations. For example, the ‘complete participant’, where the researcher takes an insider role within the group being studied, or the contrasting ‘non-participant’ case, where the researcher is not considered being part of the group under study. In the present study, this second situation characterized the observations, as the researcher was not a member of the target community.

In another aspect, as indicated by Patton (2002), “getting close to the people in a setting through firsthand experience permits the inquirer to draw on personal knowledge during the formal interpretation stage of analysis” (p. 264), recognizing that reflection and introspection are important aspects of field research. Cohen et al. (2007) further highlight that, as observations are continuous in time, to determine what counts as evidence may become cloudy, as ultimately this depends on different factors related to the observer, and to the observed setting (Cohen et al., 2007). This validity issue is where the main criticisms of observations are grounded, as different people will see different things in the same research setting, biased by their own individual backgrounds or worldview. Similarly, questions about the reliability of observations have been raised from positivistic perspectives, in terms of how repeatable data can be. However, the specificity to the context and depth of understanding is of course where the very essence of naturalistic research lies, and one of the most powerful aspects of observations (Lincoln & Guba, 1985; Patton, 2002). Hence issues of validity and reliability of observations are much the same as with any other qualitative method, for which different procedures can be followed to enhance these, e.g. triangulation of data. For details on validity and reliability aspects see Section 4.6.3.

In the context of the present research, observations of the target community were critical during the early stages of the intervention. These helped achievement of depth of understanding in relation to different aspects of the study, such as the socio-cultural, as well as the ICT and EfS characteristics and needs of the target community. Observations in the target community were carried out at different levels and scope, and within different research frames, depending on the particular study phase of the intervention. These included the spectrum from unstructured observations aimed at understanding the socio-ecological sustainability issues present in the target community, and more structured types of observational research assessing the use of the EfS website by participants during the late stages of the research.

4.4.4 Document analysis

As indicated by Lincoln and Guba (1985), analysis of documents and records, or “nonhuman” types of data, are very useful sources of data in naturalistic inquiry (p. 276). They represent low-cost, stable, and almost always available sources of information that can be used to gain depth of understanding of a particular context, and/or complement other methods of inquiry to achieve a better perspective. Document analysis can also provide historical perspectives regarding a particular educational setting, contributing to the overall understanding of the context under study (Parlett & Hamilton, 1972). More recently, Patton (2002) stressed that document analysis represents a rich source of information, with the possibility of accessing highly important documents for research purposes. Similarly, document analysis can provide accounts on events and/or situations that cannot be accounted for based on questionnaires, interviews, and/or observations. In turn, information and data obtained through document analysis may stimulate further inquiry based on, for example, interviews (Bailey, 1994).

Criticisms from positivism to document analysis have historically been related to their lack of representativeness, and to the unknown original validity and objectivity of the documents, in particular older documents

(Lincoln & Guba, 1985). Other practical drawbacks of document analysis as an inquiry method are that documents can be incomplete or inaccurate, or simply be non-existent, or sometimes they do exist but are unavailable to the study, thus limiting the research (Bailey, 1994; Cohen et al., 2007).

However, document analysis provides insights that may not be directly observable, or for which no appropriate questions were asked during an interview (Patton, 2002). It may also show the evolution of situations over time, or provide details of personal feelings that may not appear otherwise (Bailey, 1994). Ultimately, documents are social products relevant to specific contexts, which calls for a critical approach during their analysis, based on contextual interpretation of the information. In addition, the researcher must acknowledge their double hermeneutic, having to interpret a world already interpreted through different eyes, making the understanding of the document's context crucial for its analysis (Cohen et al., 2007; Giddens, 1979).

In the context of the present research, document analysis represented a highly valuable method permitting access to sources of information that would not have been possible to obtain through other methods of inquiry. In particular, much of the information that informed the design of ICT affordances and contents being included in the EfS website were obtained through analysis of a wide range of documents. However, it must be noted here that the real effectiveness of different methods of inquiry relies in their combination, where new perspectives can emerge. In addition, by integrating the information and data collected through questionnaire surveys, interviews, observations, and document analysis, the researcher can increase the validity of data by cross-checking findings, and triangulating data to compensate on any method's weaknesses with another's strengths (Patton, 2002).

4.4.5 Google Analytics tools

Google Analytics is a free analytical service from Google Inc. that provides detailed statistical information about the visitors to a website (Google,

2013). This analytical tool is primarily used for website marketing purposes, but can provide a range of valuable data regarding quantitative aspects of website use. Further details regarding different aspects of this method are reviewed in Chapter 6, which addresses the use of the EfS websites by participants of the target community. By presenting the characteristics and related issues of this method within the context of the data analysis and findings presentation of Chapter 6, a better overview of the pros and cons, and of the overall aspects of Google Analytics as an inquiry tool can be achieved. Nonetheless, because this analytical method was used to retrieve quantitative information that assisted in addressing the research questions of this study, it was necessary to mention it within this section.

The following section presents the research design of this study, showing how, and within which context, the methods presented here were used for the purposes of the present research study evaluating the use of a community-based EfS website by local community members in Chile.

4.5 Research design

This section introduces the research design of the present study. This design was framed to address the research questions presented in Section 4.2. In addition, in order to address the research questions, an EfS website was developed to be used as the research instrument for the data collection of the evaluation phase of this study. More details on the design and development of the EfS website follow in Chapter 5.

The research design of this study consisted of four phases, each one involving particular methods of data collection. The first three research phases were related to the design and development of an EfS website to be used as the research instrument. The fourth research phase involved the collection of data based on the use of this EfS website by members of the target community of this study. Next follow details on the research design, research phases, and data collection methods used during this study.

4.5.1 Study phases

The intervention and data collection of this study, related to the design, development and use of a community-based EfS website, consisted of a sequence of four study phases:

- Phase I: Planning phase
- Phase II: Pre-design research phase
- Phase III: Design phase
- Phase IV Evaluation phase

Further details of each study phase are presented below, with an indication of the purpose and expected outcomes of each phase. This is followed by Section 4.5.2, which presents the methods used during the data collection phases. Note that all research instruments used in this study were constructed in English, and then translated into Spanish for their administration. Myself as the researcher did the translations; I am fluent in both languages. In some cases translations were double checked by other people also fluent in both languages.

I. Planning phase

This phase consisted of the planning of the intervention of this study, in terms of the selection of a target community in which to carry out the intervention. This phase involved three stages: firstly, to identify a target community in Chile, and a sustainability issue affecting the target community, for which an EfS website can be developed. Secondly, the familiarization of the researcher with general aspects related to the use of Internet websites in the Chilean context, as well as within the chosen target community. This included a general overview of the type and quality of ICT and Internet penetration, and website affordances that are culturally relevant in the Chilean context, and in the chosen target community. And thirdly, a networking and partnership process with relevant individuals, organizations and groups related to the target community and chosen sustainability issue.

In the first stage, the objective was to review the Chilean national, regional and local contexts in regard to potential and suitable target communities.

This stage included different meetings and interviews with strategic people and experts knowledgeable about the general ecological sustainability of this country (n = 11, see Section 5.2.1.2), to assist with the selection of a potential target community in which to carry out the intervention of this study. These key strategic individuals and experts represented a variety of areas and disciplines, providing input from a range of perspectives in relation to the selection of a potential suitable target community for the purposes of the present research. The target community needed to comply with the following three conditions:

- Presence of a socio-ecological related sustainability issue affecting the local community;
- Presence and penetration of ICT and Internet infrastructure;
- An evident need for the implementation of an EfS intervention at the community level.

During this stage, data collection was carried out in the form of informal interviews, researcher's personal observations and notes, and audio recording for later analysis and interpretation, as a means to document and evaluate all the input given from the group of key strategic individuals and experts. More details on these participants are provided in Chapter 5.

The second stage of this planning phase included an overview of the quality and penetration of ICT and Internet in the Chilean context, and within the chosen target community. The objective of this stage was to familiarize the researcher with the general range of affordances and features that Internet websites can offer to non-formal EfS at the community level in Chile. This stage included input from four different website developers and designers, and involved some data collection in the form of informal interviews.

The third stage of the planning phase, which consisted of the networking and partnership with relevant individuals, organizations and groups related to the chosen community and sustainability issue, permitted a better understanding of the different contexts existing in the target community. These individuals, organizations and groups were both from the target

community, and from outside the target community, but in all cases related either to the target community and/or chosen sustainability issue (e.g. university academics knowledgeable on the target sustainability issue). More information and details on these experts and organizations from the second and third stages mentioned above are presented in Section 5.2.

Another aim of this third stage was to start the process of receiving input from relevant organizations, groups, and persons in the form of 'user-informed design' (see Section 2.4.3) that contributed to the design and development of the EfS website. Nonetheless, the actual user-informed design process is part of the second study phase of this research.

II. Pre-design research phase

This second study phase consisted of understanding the ecological, social, cultural and technological contexts of the chosen target community, in relation to the sustainability issue to be addressed through the EfS website. The aim of this phase was to gather all the relevant information related to the target community and the chosen sustainability issue that informed the design and development of the EfS website. In order to achieve understanding of the local socio-ecological and cultural contexts of the target community, as well as the technological context related to ICT penetration and use within the target community, this pre-design research phase involved four stages:

- An investigation process of the local, social and cultural contexts of the target community (stage 2a);
- The assessment of the existing conceptions within the target community members, in regard to the chosen sustainability issue (stage 2b);
- An assessment of the type of ICT penetration, infrastructure, and use within the target community, and a review of existing EfS websites (or similar environment related websites) already available to the target community (stage 2c);
- An understanding of the chosen sustainability issue by the researcher (stage 2d).

In the first stage, the understanding of the local, social and cultural contexts of the target community was initially achieved through the networking and partnership process from the previous phase (i.e. planning phase). During this process, key strategic persons, organizations and groups were identified and invited to provide input from their perspectives about a variety of topics related to the target community, in relation to the chosen sustainability issue (e.g. ICT and Internet infrastructure, community members' general level of ICT skills, existing interests regarding sustainability issues, economic aspects, etc.).

This stage involved interviews (n = 11; see Appendix A for details on the research instrument), observations and notes, and audio recordings of the interviews as data collection methods. This was conducted to document and evaluate all the received input from such key strategic persons, organizations and groups that participated of this process. A second method of data collection for the understanding of the local, social and cultural contexts of the target community in relation to the chosen sustainability issue was the revision and analysis of relevant documents and existing data regarding the target community and its relation to the chosen sustainability issue.

Concerning the second stage involving the investigation of the existing conceptions among community members of the target community, a questionnaire survey was carried out with nineteen local community members who accepted an invitation to participate in the survey (survey 2b 'Existing sustainability conceptions'; see Appendix B). This questionnaire survey was administered in public places of the target community, for example within city parks, public library, and the local council building (see Section 5.3.1), and included a range of open and closed questions related to the chosen sustainability issue.

The aim of the questionnaire survey was to assess the type and level of knowledge of participants concerning the chosen sustainability issue affecting the local community, and to identify the range of potential

alternative conceptions existing within participants of the survey in relation to the local sustainability issue. The identification of such alternative conceptions permitted the EfS website design team to guide the development of educational affordances and content of the EfS website, and, in the case of the presence of such alternative conceptions, to directly target them through, for example, a 'challenging beliefs' learning strategy (i.e. for details of this approach refer to Section 3.2.1).

The third stage of this pre-design research phase involved assessment of the technological characteristics existing in the target community. This included a review of existing EfS websites (or similar types of environmental websites) available to the target community, and a survey addressing levels of ICT access and skills, and Internet websites preferences among participants of this survey (survey 2c 'Existing websites preferences'; n = 19; see Appendix C). Note that participants of survey 2c were recruited in the same way as participants for survey 2b (see Section 5.3.21), and that in a few cases the same participant was invited to participate in both surveys.

This research stage permitted the understanding of the local context in terms of use of websites within the target community, as well as the identification of website features and affordances that seemed to be relevant and meaningful to participants of the survey. Data collection during this research stage was carried out in the form of a questionnaire survey that included a short interview during the survey, in order to assess participants' website preferences.

During the interview participants were shown different types of websites and asked to identify the websites' affordances and features that were relevant to them (i.e. user-informed design process). This assessment of participants' website preferences helped guide the design phase of the intervention (phase III), particularly the design and development of the EfS website's affordances.

The last stage of this pre-design research phase consisted of developing the understanding of the chosen sustainability topic and issue by the researcher, as a means to enhance the whole process associated with the design and development of an EfS website for the target community. The understanding of the chosen sustainability issue, within the context of the target community, allowed the researcher and the design team of the EfS website to address relevant aspects related to the main sustainability issue affecting the target community within the EfS website. This stage involved data collection in the form of analysis of existing documents, as well as interviews with the key strategic individuals, organizations and groups identified during the networking and partnership process from the planning phase (n = 11; see Appendix D).

III. Design phase

Once the planning and pre-design research phases were concluded, the third study phase of this research involved the design and development of an EfS website to address the socio-ecological sustainability issues affecting the target community. This design phase was carried out based on all the information and data collected during the previous two phases, and following the guidelines of the theoretical model for the development of EfS websites presented in Chapter 3. The objective of the development of such an EfS website was to use it as the research instrument for the evaluation of the use of EfS websites at the community level, and its potential for the promotion of understanding and action around socio-ecological sustainability issues among members of the target community.

As a means to develop a relevant and meaningful EfS website for the target community, the design and development of the EfS website was carried out within a user-informed design format. This means that during the design and development of the website local community members were invited to get involved and participate in the design process. A detailed review of this design phase and all related aspects is presented in Chapter 5 addressing the intervention of this study, where the chosen target community and socio-ecological sustainability issue are introduced.

IV. Evaluation phase

This fourth study phase corresponded to the evaluation of the use of the EfS website by local community members of the target community. This evaluation phase aimed to address the third and fourth research sub-questions of the present PhD research project, and evaluate if the EfS website developed during the design phase of this study promoted understanding of sustainability issues affecting the target community; action towards the local socio-ecological sustainability at the target community; and the adoption of ecological sustainability principles and practices among local community members. The next section introduces more details on the data collection methods carried out during the study phases.

4.5.2 Data collection

This section presents details on the methods used during the different data collection phases of this study. Different types of data were collected during the four study phases highlighted in the last section. As mentioned earlier, the data collected during the first three phases, i.e. the planning phase, the pre-design research phase, and the design phase, were aimed to inform the design and development of an EfS website that served as the research instrument during the fourth study phase.

Table 4.2 presents a summary of the data collection phases, methods, and other associated issues related to the design and development of the EfS website. Details of the methods from these three study phases were indicated in the last section. In addition, further details of this design and development process follow in Chapter 5, which presents the application of the theoretical model from Chapter 3 in the context of the target community in Chile.

Table 4.2. Data collection phases, methods, and associated issues related to the design and development of the EfS website *Lanalhue Sustentable*.

Research Phase	Objective	Methods	Sample (n) *	Recruitment
I. Planning phase				
1a. Determine target community / sustainability issue	Analyze the general EfS, ICT and sustainability contexts in Chile	- Interviews - Document analysis	9	- Invitation - Networking
1b. Networking and partnership	Meeting with strategic individuals and groups about the target community	- Interviews - Document analysis	9	- Invitation - Networking
II. Pre-design research phase				
2a. Understanding target community's contexts	Input from key strategic individuals and organizations regarding target community	- Interviews - Document analysis - Observations	11	- Invitation - Networking
2b. Assessment of existing conceptions	Survey on community members regarding existing sustainability conceptions	- Questionnaire survey	19	- Invitation - Public advertisement

Research Phase	Objective	Methods	Sample (n) *	Recruitment
2c. Websites preferences	Survey on community members regarding preferences over websites affordances	- Interviews - Questionnaire survey	19	- Invitation - Public advertisement
2d. Understanding of sustainability issues at target community	Input from key strategic individuals and organizations regarding sustainability issues	- Interviews - Document analysis - Observations	11	- Invitation - Networking
III. EfS website design phase				
3a. Design and development of EfS website	Input from web design experts, web design team, and local community members	- Interviews - Observations	5	- Invitation - Networking

(*) Note that phases 1a and 1b, and 2a and 2d involved the same cohort of participants respectively.

The fourth study phase, the evaluation, included four data collection instances related to the assessment of the use of the EfS website by participants. These four data collection stages of the evaluation phase were the following:

I. Pre-intervention questionnaire (see Appendix E);

II. Intervention: use of the EfS website;

III. Post-intervention interview (se Appendix F);

IV. Follow-up online survey (seen Appendix G).

Table 4.3 presents the data collection phases, methods and associated issues related to the assessment of the use of the EfS website by community members of the target community. Participants of this evaluation phase were contacted and invited to participate by means of advertisement in public areas of the chosen target community, and by direct invitation while approached in public areas by the researcher. The recruitment of participants considered their own agreement and willingness to participate.

Table 4.3. Data collection phases, methods, and associated issues related to the evaluation of the use of the EfS website by local community members (i.e. evaluation phase).

Research Phase	**Objective**	**Methods**	**Sample** (n)
4a. Pre-intervention questionnaire	Assessment of demographics, ICT skills, and knowledge about local sustainability issues	Questionnaire survey	24
4b. Intervention: use of the EfS website by participants	Qualitative data collection on the use of the EfS website	Google Analytics	
4c. Post-intervention interview	Assessment of the perceptions of the website, change in understanding, and motivation to take action	Interview	
4d. Follow-up survey	Evaluation of change in understanding, actions carried out, and adoption of sustainable living principles based on website revisits during follow-up period	Online questionnaire survey	18

Note that all recruitment was done through public advertisement and direct invitation.

This included seeking participants' consent to get involved in the research through an invitation letter that explained the objectives of the research and the expected involvement by the participants. Twenty-four local community members accepted the invitation and were recruited to participate in this evaluation phase. Participants represented a mixed cohort in terms of gender, age, and place of residency, but were all considered members of the target community (more details are provided in Section 6.2.1).

Below follows some brief descriptions related to the data collected during the evaluation phases of this study presented in Table 4.3.

I. Pre-intervention questionnaire

During this stage, participants were asked to complete a pre-intervention questionnaire before visiting the EfS website for the first time. The questionnaire aimed to identify each participant's demographic characteristics, existing knowledge regarding the chosen sustainability issue, and background concerning the level of skills of ICT and Internet use. To achieve this, the questionnaires included close-ended demographic questions, open-ended questions, multiple-choice questions, dichotomous questions, and rating scale questions. This questionnaire was approximately 5 to 10 minutes long, depending on each participant, and included a total of twenty questions.

II. Use of EfS website by community members

Immediately after the pre-intervention questionnaire survey, participants were invited to visit and browse the EfS website for the first time. During this stage, quantitative data regarding the use of the EfS website as a cohort was retrieved using Google Analytics (Google, 2012) tools, about the type of usage of the EfS website *Lanalhue Sustentable* during the intervention period. Further details on this method are discussed in Chapter 6. But in essence, this method helped quantify the type of use of the EfS website in relation to the type of content visited at the cohort level. The use of the EfS website by participants lasted between 10 to 20

minutes, depending on participants' motivation and time availability; and was carried out in public areas of the target community (i.e. such as library, community house or cafes), and through the use of a laptop and/or desktop computer provided by the researcher. In some occasions participants were able to browse the EfS website from their own computer.

III. Post-intervention interview

In order to assess the experience of participants from their visit to the EfS website, an interview was carried out immediately after participants' first use of the website. The interview principally allowed evaluating if participants felt they had enhanced their understanding around the existing sustainability issues at the target community. This interview was a semi-structured type of interview, principally based on open-ended questions such as: what did you learn? Did you or did you not know about this before (a particular issue related to the chosen sustainability issue)? Did you know about the existing relationships between these aspects and these other aspects of the sustainability issue? What does it mean to you? Do you care? Why did you visit this particular topic, and what for? And so on. The objectives of these questions were to evaluate not only change in understanding, but also motivations to take action and to adopt sustainable living principles, as well as participants' perceptions towards the EfS website.

IV. Follow-up questionnaire survey

The follow-up online questionnaire survey, carried out 5 months after participants' first visit to the EfS website, aimed to assess the types of use of the EfS website by participants over time, i.e. revisits during the follow-up period. In particular, this follow-up stage investigated if participants retained knowledge, sought more knowledge, presented an understanding change over local socio-ecological sustainability issues, and/or carried out any particular action related to local sustainability issues, based on revisits to the EfS website. This follow-up online questionnaire took approximately 10 minutes to complete, and consisted of an online survey accessible from a link sent through email to follow-up participants (18 of the original 24

participants chose to participate in this stage, n = 18/24). The survey included open-ended questions, close-ended questions, multiple choice questions, and dichotomous questions. In addition, as part of the follow-up, the five apparently most committed participants were identified and asked to be part of an intensive group. This group had more regular contact with the researcher (i.e. by email), providing more depth of data related to their revisits to the EfS website during the follow-up period. The principal involvement of the intensive group was to clarify responses of the follow-up survey, e.g. clarification of type of actions undertaken based on the EfS website.

Finally, it needs to be mentioned that prior to this data collection phase using the EfS website as the research instrument, a pilot phase was carried out to ensure that the data collection instruments were meaningful in the same terms to both the researcher and to participants. This pilot stage included the participation of five local community members who were recruited through the same procedure as above. For further details on each research instrument used during this study, please refer to the appendix.

The next section introduces the data analysis procedures employed in this study, including issues related to data validity and trustworthiness, and issues related to ethical procedures adopted during data collection phases.

4.6 Data analysis

This section presents the analytical procedures of this study. Data analysis is the process of making sense of the raw data into findings, where the researcher pulls out information from the data to answer the research questions while accounting for methodological considerations. For qualitative data, there is no particular or correct way to analyze and present data. Although guidance may be available, such a process remains unique for each researcher (Patton, 2002). Regarding quantitative analysis, in naturalistic inquiry quantitative data generally helps to support

qualitative-based findings, for example, descriptive statistics assist with finding correlations and providing measures of tendency within answers to questionnaires by participants (Cohen et al., 2011).

The first part of this section presents activity theory (AT), a descriptive meta-theory and analytical framework that accounts for the overarching components of social systems influencing human activity (Salomon, 2001). Activity theory has been chosen in this study as a conceptual framework to make sense of data from a cultural-historical point of view. The second part of the section reviews the coding and analytical procedures used to interpret collected data.

4.6.1 Activity theory

The use of an EfS website as an educational tool to promote learning for community members involves phenomena occurring within a network of complex relationships between social, cultural, technological, ecological and educational dimensions. Social communities are cultural entities comprising dynamic structures, where each individual brings into the learning process their unique conceptions, backgrounds, expectations, motivations and needs (Brookfield, 1990; Kaptelinin, Kuutti & Bannon, 1995; Cole & Engeström, 2001; Novak, 1987). As mentioned earlier, a systems thinking approach has been adopted in this study to address such complex and dynamic settings, where the focus of attention is on the relations and connections existing between these different dimensions (Orr, 2004; Somekh, 2007; Sterling, 2001). Nonetheless, although a systems thinking approach can provide accounts to understand complex and unpredictable phenomena, such as the use of ICT for community EfS, it is not a suitable learning theory within the naturalistic approach of this study because it pays little attention to cultural and historical contexts of human activity (Leadbetter, 2005).

On the other hand, constructivist perspectives highlight that the human experience is socially constructed, where reality is shaped based on social factors and cultural historicity (Kelly, 1991; Mertens, 2005). This implies

that community members using an EfS website construct a reality based on such experience, and on socio-cultural factors. However, as above, the individual and social construction of reality based on an ICT tool occurs within complex and unpredictable settings.

Considering that ICT and EfS phenomena are seen here to occur in a complex and unpredictable way, but learning is approached from an interpretivist/constructivist perspective, activity theory as a conceptual framework offers a common ground of inquiry within such a setting. Activity theory (AT) provides conceptual elements to account for educational, social, cultural and technological components of human activity, while considering the complexities, change, adaptation and expansion of activity systems (Krasny & Roth, 2010; Yamagata-Lynch, 2007). From an AT perspective, people are socially-culturally embedded actors, where cognition is distributed within the members of a community, and shaped by the 'technological artefacts' or 'tools' available to the community (Cole & Engeström, 2001). This calls for accounts of the entire social and cultural contexts of the person and the larger community, their developmental history, role of an available set of artefacts, and complexity and dynamism of real life situations and actions (Kaptelinin et al., 1995; Leadbetter, 2005).

The basic unit of analysis in activity theory is a tool-mediated, and goal-oriented, activity system. Such a system is composed by the individual or collective 'subject', which engages into an activity by interacting with artefact or tool, and directs the activity towards a goal of 'object', which in turn produces an 'outcome' of the activity system (Kaptelinin et al., 1995). This is what is known as a first generation activity system (Krasny & Roth, 2010). Figure 4.1 shows a second-generation activity theory, based on Engeström's model of an activity system (Engeström, 1987), where the original basic unit of analysis from the first generation is expanded to include a collective view of an activity system. In this second version, the 'rules', 'community', and 'division of labour' intersections in Engeström's

model shown in Figure 4.1 represent the structural, historical, and cultural dimensions of an activity (Engeström, 2001).

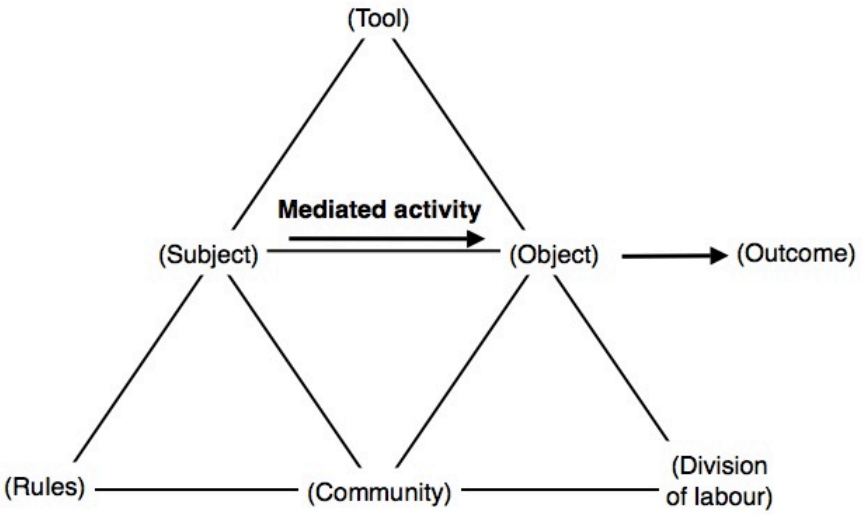

Figure 4.1. Structure of a second-generation activity system (adapted from Engeström, 1987).

A third generation of the original activity system model from Engeström (1987) has been described (Engeström, 1999; Krasny & Roth, 2010; Leadbetter, 2005). This third version involves two or more interacting activity systems, forming a network of activity systems, where the outcomes of an activity system can later become the subject of subsequent activity systems (Engeström, 2001). The novelty here is that this third generation accounts for the dynamism and complexity of human behaviour, characterized by constant transitions, reorganizations, and expansion of activities (Cole & Engeström, 2001). This third generation expansive activity system was developed aimed at providing conceptual tools “to understand dialogues, multiple perspectives and networks of interacting activity systems” (Leadbetter, 2005, p. 25).

In summary, activity theory as a descriptive analytical framework accounts for the context, culture, history of the learner and its community, structure of the community, role of the artefact, learners’ motivations, and the complexity and dynamism of real life activities. It also provides the possibility of multiple points of views, traditions, and interests, which

characterizes social systems (Cole & Engeström, 2001). In the context of this study, activity theory was adopted because it accommodated systems thinking, complexity theory, and constructivist approaches of social learning, by focusing on the relations existing between learners, technological artefacts, and the socio-cultural and ecological milieu. In the coming chapters, activity theory is used as an interpretive and sense-making lens throughout the analytical processes related to the use of an EfS website by local community members in the context of the Lanalhue Lake in Chile.

The coming section introduces the analytical procedures used to code and analyze data collected during the intervention of this study, which was interpreted using activity theory, in consideration of the methodological frame and research questions of this inquiry.

4.6.2 Data coding and analysis using software tools

Qualitative data analysis involves the organization, explanation and interpretation of data, in consideration of the participants' definition of the situation. This process usually involves the search for patterns, themes, and categories of regularities present in the data (Cohen et al., 2011). As mentioned earlier, there is no single and correct way to analyze and present qualitative data, as data analysis relies on interpretation and there are multiple possible interpretations from a set of qualitative data (Patton, 2002). The selection of a particular method of data organization, interpretation and presentation depends on the purposes of the inquiry, which is guided by the research questions. Another issue of qualitative data analysis is that, at a theoretical level, preliminary analysis often begins early during the data collection, which in turns helps to reduce data overload by selecting significant features for future focus (Cohen et al., 2007).

In this study, data collected during the intervention was analyzed following La Pelle's "clever but simple" qualitative data analysis method (2004, p. 85). This method is based on the use of Microsoft Word tables and

associated data management tools, for the organization, coding, interpretation and presentation of data. As indicated by Miles & Huberman (1994), the use of table structures is a powerful analytical tool that can be used as a manageable database for analysis. La Pelle (2004) proposes a seven step method for analysis of qualitative data based on Microsoft Word Tables, which for the purposes and focus of the present research was adapted to five core steps:

I. Format qualitative data into tables

This is the first step where raw qualitative data is broken apart into smaller units of analysis, usually based on specific answers addressing main themes. Then every unit of analysis is formatted in a tabular format. This is the insertion of the data in a table containing at least four columns (i.e. participant ID, text data, code, and sequence number). In this way, every unit of analysis is related to its source, a theme code, and a unique identifier number (sequence number).

II. Develop a Theme Codebook

“In preparation for analysis, a theme codebook is created by reading a representative sample of interviews and noting the themes that seem to recur or that have significance to the study” (La Pelle, 2004, p. 88). Note that other sources of qualitative data can be used here. In addition to recurrent themes from the data, the Codebook has to include theoretical themes that are significant to the study. In the case of this study, the 3-level Codebook included theoretical considerations from EfS, systems thinking, ICT, community education, and activity theory, as well as practical considerations from the target community identified during the pre-design research phase (more details about these follow in Chapter 5). The Codebook of this research ended up representing the backbone of the whole study, as it included theoretical and practical aspects, analytical aspects, recurrent themes from the data, and aspects related to the research questions of this study. Refinement of the Codebook was carried out throughout the analysis. For details on the Codebook, please refer to Appendix H.

III. Coding of data

Although the development of the Codebook involves some degree of analysis of data, so as to find recurrent and significant themes, this third step represents the principal analytical stage of this method. Every unit of tabular data is coded based on themes from the Codebook. Depending on the detail of analysis in relation to a particular theme, each unit of analysis, or segments of it, can be coded more than once. In this case a sequence number assigns a unique ID to every piece of coded data. Note that there are different approaches to coding (La Pelle, 2004; Miles & Huberman, 1994). In particular, descriptive coding implies the coding of data strictly based on the perceived raw data, without including any interpretation of data. Whereas, an inferential coding involves interpretation of data, usually involving coding of data against theoretical themes, e.g. making sense from an activity theory frame.

IV. Sort data tables / find patterns

After coding, this fourth step includes more complex analysis involving the sorting and organization of data based on analytical criteria, with the aim to find patterns, recurrence, regularities and categories of themes. Here, sophisticated search and sorting tools from Microsoft Word permit the visualization of data based on particular criteria, for example, grouping all data coded under a particular theme of interest. In the case of this study, the sorting of data to find patterns and recurrence included analysis based on activity theory, and underpinned by the chosen methodology and research questions of this inquiry.

V. Code validation

This final stage involves the validation of the theme codes from the Codebook. The researcher reviews all data coded under a certain theme code, and validates the original meaning of the code, or corrects it along with all data coded under such a code.

Overall, this method can be a complete and thorough qualitative data analysis method based on the manual handling of data formatted into

Microsoft Word tables. The five steps presented above are long but rewarding, as it provides an overall control over qualitative data, and facilitates the process of meta-analysis, and the presentation of data. In the findings chapters (Chapters 6 to 8), data is presented based on the original tabular format used during analysis, with constant reference to theme codes from the Codebook.

In naturalistic inquiry quantitative data generally helps to support qualitative-based findings, for example, descriptive statistics assists with finding correlations, or by providing measures of tendency within answers to questionnaires (Cohen et al., 2011). Quantitative data collected in this study principally was related to Google Analytics data addressing statistical use of the EfS website developed as a research instrument (see Chapter 5), and data related to demographics characteristics of the cohort of participants. This type of data was used in this study to support and complement findings based on qualitative data, as well as to provide methods of validation, for example, data validity through triangulation of qualitative and quantitative data from different sources (Somekh & Lewin, 2005). More on data validity and trustworthiness follows in the next section.

4.7 Data validity and trustworthiness

Validity and trustworthiness of data and findings is a requirement of any type of educational research. Whether carried out within a positivistic or naturalistic tradition, or based on qualitative and/or quantitative sources of data, validity “is the term used to claim that research results have precisely addressed research questions” (Somekh & Lewin, 2005, p. 349). Regarding trustworthiness, Lincoln and Guba (1985) indicate that this term is related to the issue of a piece of research being worthy of attention. In other words, research that is invalid and worthless is of low quality (Cohen et al., 2007). But then, what constitutes validity and trustworthiness? Patton (2002) argues that it all depends on criteria. This is, research can be of quality or not depending on the ontological, epistemological, and methodological approaches adopted during the inquiry, as well as on the

approaches and criteria taken to judge the quality of such research. Different research paradigms have different criteria to determine quality and validity of research.

For example, the concept of reliability, which involves the 'possibility of replication', is a common criterion within a positivistic research tradition. But it cannot be accounted for in those terms within a naturalistic perspective, as such inquiry approach asserts that each real life context that can be studied is unique, thus, not replicable (Cohen et al., 2011). In qualitative research, which occurs within the natural setting, reliability can be regarded as a degree of accuracy and comprehensiveness of coverage of recorded data (Bogdan & Biklen, 1992). Cohen, Manion and Morrison (2007) further argue that reliability in qualitative research involves fidelity to the real life inquiry context, authenticity, honesty, depth of response and meaningfulness to participants. Moreover, Maxwell (1992) suggests that 'understanding' is a more appropriate term than validity, in qualitative research.

Lincoln and Guba (1985) describe four criteria of the 'traditional' positivistic paradigm that account for validity and reliability: internal validity, external validity, reliability and objectivity. Although Cohen et al. (2007) indicate that internal and external validity can be addressed both within quantitative and qualitative methods, Maxwell (1992) argues for five kinds of validity in qualitative research that explores his notion of 'understanding': descriptive validity, interpretive validity, theoretical validity, generalizability, and evaluative validity. Other scholars in the field of naturalistic inquiry describe different criteria for judging quality of inquiry. For example, Patton (2002) advocates for trustworthiness, authenticity, triangulation, reflexivity, particularity, and enhanced understanding, among others.

In the case of the present research, as a naturalistic tradition has been chosen as the inquiry paradigm, the four concepts defining trustworthiness in naturalistic paradigm indicated by Guba and Lincoln (1989) were adopted here as the criteria of validity. These four concepts of

trustworthiness are: credibility, dependability, confirmability, and transferability. Below follows a brief review of these concepts of trustworthiness, with an indication of its application and/or implication in the present study.

Qualitative research relies on description, interpretation, and explanation. In this sense, credibility of inquiry is related to the issue of description, interpretation and explanation being credible (Janesick, 2000). Lincoln and Guba (1985) propose five techniques to increase the credibility of naturalistic inquiry (p. 301):

- Activities that make it more likely that credible findings and interpretations will be produced: prolonged engagement, persistent observation, and triangulation.
- An activity that provides an external check on the inquiry process (peer debriefing).
- An activity aimed at refining working hypotheses as more and more information becomes available (negative case analysis).
- An activity that makes possible checking preliminary findings and interpretations against archived 'raw data' (referential adequacy).
- An activity providing for the direct test of findings and interpretations with the human sources from which they have come – the constructors of the multiple realities being studied (member checking).

As discussed earlier in relation to the research design of this study, and as further discussed in Chapter 5 in relation to the intervention of this study, activities related to prolonged engagement (familiarity with inquiry setting) and persistent observation (identification of key elements of the study) were an integral part of this inquiry. Also included were activities and instances related to peer debriefing, referential adequacy and member checking. Regarding negative case analysis, where the object is to continuously "refine a hypothesis until it accounts for all known cases without exception" (Lincoln & Guba, 1985, p. 309), such an analytical and

interpretive process was also considered in this inquiry, and highlighted throughout the findings chapters (Chapters 6 to 8).

Finally, triangulation is a powerful analytical and validity tool in qualitative research consisting of the cross-validation of data obtained from different sources and perspectives (Somekh & Lewin, 2005). During the 1970s, Denzin (1978) identified four basic types of triangulation: data triangulation; investigator triangulation; theory triangulation; and methodological triangulation. Apart from the investigator triangulation, the remaining three types of triangulation were included in the analysis of this study, and are indicated in the following findings chapters. Regarding investigator triangulation, this study only included one researcher. Nonetheless, it could be argued that investigator triangulation, or the use of different perspectives to interpret a set of data, can partially be accounted for through peer debriefing. In particular, supervisors of this PhD thesis acted as such during the analytical phase of this inquiry.

Dependability of data is a criterion for trustworthiness in qualitative inquiry that refers to the provision of a clear, thorough and thick description of the data collection process, as well as of the context of inquiry (Lincoln & Guba, 1985). Techniques to achieve dependable data also include the full description of assumptions made during the research, presentation of a clear audit trail of how data was collected, and triangulation of data. It is argued here that this research study complies with such criteria. Full descriptions, audit trails, and evidence of triangulation of data follow in the next chapters addressing the intervention of this study (Chapter 5), the findings of this study (Chapters 6 to 8), and the discussion of this study (Chapter 9).

Regarding the issue of confirmability of naturalistic inquiry, Lincoln and Guba (1985) describe confirmability as a measure of objectivity for naturalistic research. The principal technique to achieve confirmability is the provision of a thorough and in-depth audit trail of the research. These authors argue that “a single audit, properly managed, can be used to

determine dependability and confirmability simultaneously" (p. 318). As for dependability as discussed above, a full description and audit trail of this research is included in the following chapters.

Finally, the last criterion of trustworthiness of qualitative and naturalistic inquiry indicated by Lincoln and Guba (1985) is the concept of transferability. The positivistic version of transferability of qualitative research is the concept of external validity, which refers to the degree of generalization of the findings of a study (Cohen et al., 2007). Nonetheless, ontological and epistemological approaches of naturalistic inquiry make generalization within naturalism, "in a strict sense", impossible (Lincoln & Guba, 1985, p. 316). In naturalistic inquiry the researcher can only set out working hypotheses based on a description of the time and context in which such hypotheses were found. Whether such hypotheses can be found in a different context or time is a matter of empirical research (Lincoln & Guba, 1985). So, instead of specifying the external validity and generalizability of qualitative and naturalistic inquiry, the naturalist researchers can provide the necessary thick description of the contexts and methodology of a study, for someone else interested in such work to decide if findings are transferable into conclusions valid in other settings. A thorough and thick description of the research setting and contexts were described in this study. Whether findings from this study are transferable to other settings can be decided by the reader, and/or investigated in future research.

4.8 Ethical considerations

Ethical dilemmas and concerns are part of the process of doing any research (Guillemin & Gillam, 2004). Some authors argue that ethical accounts within a research project are part of the criteria that determine the quality of the research (Groundwater-Smith & Mockler, 2007). Such views of the importance of considering ethical aspects within educational research are adopted and strongly supported in this study.

In a brief review, the ethical concerns regarding research involving human participants, included in the Ethical approval obtained from the Human Research Ethics Committee, involved the following ethical considerations: type of access to participants; giving informed consent to participate; confidentiality; assessment of any potential harm to participants; participant's right to decline; arrangements for participants to receive information; type of use of information obtained from participants; assessment of possible conflicts of interests; and procedures for resolution of disputes (for details on these ethical concerns refer to Appendix I). In addition, participants owned the raw material collected, with any request regarding such material being honoured. Note that there was no ethical requirement on the part of Chilean authorities concerning this study.

4.9 Summary

This chapter presented different aspects related to the methodology adopted during this research study. The first part reviewed common inquiry traditions and paradigms within educational research, making the case for the selection of a naturalistic inquiry paradigm, with a focus on interpretivist/constructivist approaches as part of the methodology. Following the review of inquiry paradigms, a description of the methods used in this study was presented. This included the characterization of the following methods: questionnaires, interviews, observations, document analysis, and the use of Google Analytics tools to evaluate the use of the EfS website developed in this study in quantitative terms (e.g. sections visited within the website).

The second part of this chapter consisted of the description of the research design of this study. This included the presentation of the different study phases, as well as issues related to the data collection, participant's recruitment, sample size, and methods used during each data collection stage. Following this, the third part addressed issues related to data analysis and data interpretation. This included the presentation of activity theory as the descriptive and analytical framework used in this

research, and the introduction of methods used for data analysis and data coding. In particular, the use of software tools for analysis was highlighted.

The last part of this chapter discussed issues related to data validity and trustworthiness, including the presentation of different protocols and techniques within naturalistic inquiry to enhance the validity, reliability and trustworthiness of data and findings considered in this study. Finally ethical concerns and issues related to this research were presented.

Having reviewed the theoretical grounds of this study in Chapter 2, including the model for developing EfS websites presented in Chapter 3, and the methodology adopted reviewed in this chapter, the next chapter moves on to the presentation of the intervention phase of this study.

CHAPTER 5 - INTERVENTION

5.1 Introduction

This chapter describes aspects related to the intervention of this study. The socio-ecological context present at Lanalhue Lake in central-south Chile was chosen as the target community of this study, both to apply and trial the theoretical model for the development of EfS websites presented in Chapter 3, and to research the use of ICT for EfS at the community level. The main sustainability issue present at Lanalhue Lake is the accelerated eutrophication of the waters of the lake. This means that the levels of organic nutrients have increased in the lake during the past decade, principally due to factors related to the anthropogenic activity within the catchment of the lake.

The objective of the present chapter is to introduce the socio-cultural context, characteristics and needs of the target audience, in relation to the design and development of an EfS website addressing the sustainability issues present at Lanalhue Lake. In order to illustrate the application of the theoretical model from Chapter 3, this chapter is based on the three different phases recommended in the model for the development of a community EfS website. Firstly, Section 5.2 presents data obtained about characteristics of the socio-ecological context of the target community. This corresponds to the planning stage of the process of developing an EfS website, where the objective is to evaluate the target community and the potential use of an EfS website.

The second phase of the design of an EfS website is the pre-design research phase. The aim here is to achieve a deep understanding of the social and cultural characteristics and needs of the target community, and of the existing sustainability issues present that affect the wellbeing of this community. Section 5.3 addresses this phase by presenting data collected through questionnaires, observations and interviews, and includes some interpretation of the findings in relation to the development of an EfS website for the local context.

Finally, Section 5.4 combines theoretical aspects from the model for developing EfS websites, and findings from the pre-design research phase, into a framework for designing and developing an EfS website in the context of the socio-ecological sustainability of Lanalhue Lake. Based on such a framework, the EfS website *Lanalhue Sustentable* (i.e. http://lanalhuesustentable.cl) was developed, and used as a research instrument to investigate the use of Internet websites for education for sustainability at the community level.

5.2 Socio-ecological context of the intervention: The Lanalhue Lake in Chile

This section introduces the socio-cultural, socio-ecological and technological contexts of the target community of this study, and the potential for the use of an EfS website for community education. Note that the accounts presented here are principally based on information collected during the 'planning phase' of this intervention. This included informal interviews with general experts, observations, and document analysis of relevant information. Further details on these general experts can be found at the end of this section.

5.2.1 Socio-ecological background of the target community

The Lanalhue Lake (Lat. 37.5° S), situated approximately 180 km South of the main city of Concepción in the Bio-Bio Region, and 15 km from the coast of the Pacific Ocean, is one of the few coastal lakes present of Chile. It is part of the Nahuelbuta Range (175 km long), which is considered a biodiversity hot spot at the global level due to its high degree of endemism (Myers, 2005; WWF, 1999). The area of the lake covers 3,190 hectares, and is nurtured principally by fluvial waters, in contrast to the majority of Chilean lakes that are nurtured by glaciers and snow waters from the Andes. The lake presents a very slow renewal rate of its waters due to its hydrographical, and local climate characteristics (i.e. approx 1400 mm of rain per year, principally during winter and spring) (Parra et al., 2003). This seasonal rainfall factor makes the water level of the lake fluctuate between ± 3 to 5 meters, which in turn has some

associated ecological consequences, for example, washing away cattle land during winter time, which contributes to the increase of organic nutrients in the lake.

The Lanalhue Lake is close to two major towns: Contulmo, near the South-East shores of the lake, with approximately 1500 inhabitants (i.e. ± 6000 during summer); and Cañete, 18 km North of the lake, with approximately 22,000 inhabitants (see Figure 5.1). Each one of these is the main town of the two political districts of which the lake is part, both with independent local Council authorities. There are also three other smaller populated areas by the shores of the lake: Peleco (Cañete district), and Lanalhue and Elicura (Contulmo district); as well as some areas with a growing presence of holiday cottages and residential houses along the shores of the lake. In Figure 5.2 a panoramic view of the lake can be seen. In general terms, this region of Chile is considered socio-economically as highly vulnerable because of high levels of poverty and low levels of development (MIDEPLAN, 2010). The Lanalhue Lake area is also originally a Mapuche area (Chilean indigenous inhabitants), with a high number of Mapuches still present in the area, and some Mapuche communities within the catchment of the lake and surrounding valleys, which makes this area unique from a social and cultural point of view.

In terms of sustainability issues, it is important to highlight that the main economic activity present in the area is the forestry industry, with large pine (*Pinus radiata*) and eucalyptus (*Eucalyptus sp*.) plantations across the Nahuelbuta Range (Pauchard, Smith-Ramírez & Ortiz, 2006; Smith-Ramírez, 2004; WWF, 1999). The forestry industry started explosively during the mid 1970s, and today large forestry plantations can be seen within the catchment of the Lanalhue Lake (Comisión Lago Lanalhue, 2007). Other major economic activities present in the area are related to agriculture and tourism industries, with an evident increase of holiday cottages and tourism facilities and services in some sectors of the lake in the past ten years (Etchepare & Furet, 2008).

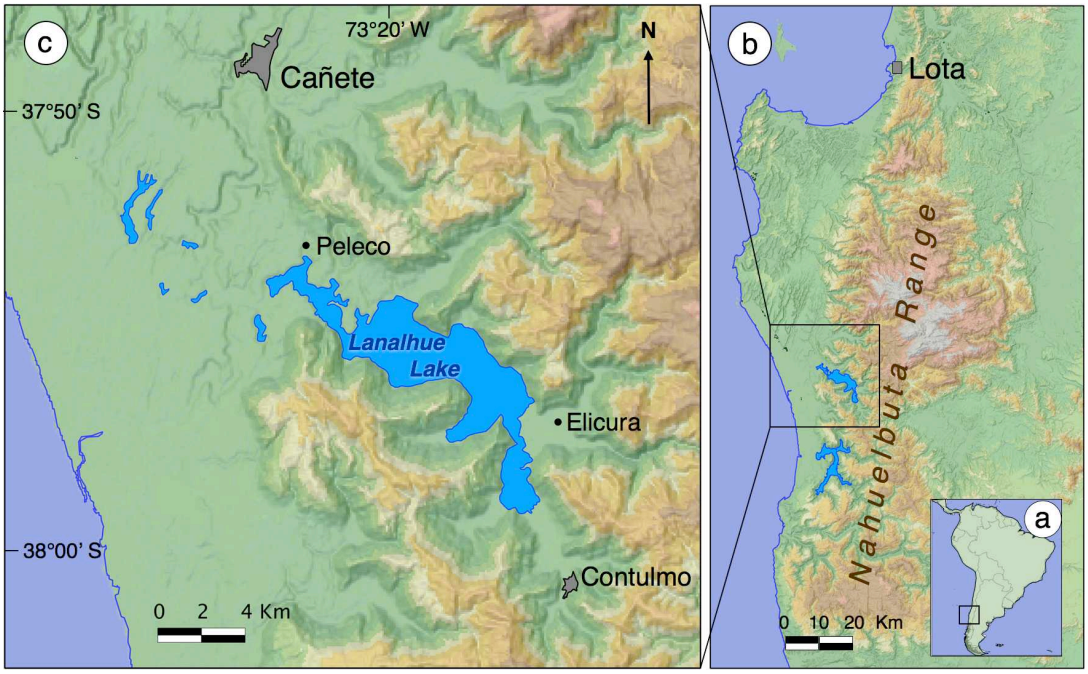

Figure 5.1. Geographical location of the Lanalhue Lake in Chile. Diagram (a) shows the location of the lake within the South-American continent. Diagram (b) shows the location of the lake in the context of the Nahuelbuta Range in Chile; and diagram (c) in the context of the local communities present in the area of the Lanalhue Lake.

Figure 5.2. Panoramic view of the Lanalhue Lake in Chile.

Historically, and arguably, the natural conditions of the lake's catchment have increasingly been perturbed by human settlement in the area since the time the first Spanish conquistadores came in their search of gold within the catchment of the lake during the XVI Century (Comisión Lago Lanalhue, 2007), to the contemporary human settlement existing in the area. The anthropogenic use of the land within the catchment of the lake has contributed to a significant alteration of the original ecological and natural conditions of the Lanalhue Lake, including water quality deterioration, increase in organic nutrients and sedimentation, and the consequent accelerated process of eutrophication of the lake (Etchepare & Furet, 2008; Pauchard et al., 2006).

According to knowledgeable individuals from the local community, due to the type of land management of the lake's catchment over the past decades, particularly related to forestry, agriculture, and tourism activities, the levels of organic nutrients present in the lake have increased to such a level that has produced the acceleration of the natural tendency of eutrophication of the lake (i.e. ecological life-cycle of the lake) (Comisión Lago Lanalhue, 2007; Mazzeo, 2005; Red Contulmo, 2007). The most apparent environmental and sustainability issue worrying local authorities and community members, which is related to the increase of nutrients in the lake, is the proliferation of the *Egeria densa* aquatic plant (i.e. common name "luchecillo"), originally from Brazil and considered an invasive plant and a eutrophication indicator (see Figure 5.3) (Centro Regional de Estudios Ambientales [CREA], 2010; Lanalhue Sustentable, 2011).

The luchecillo started to be noticed by locals around the year 2000, with significant proliferation in the years 2002 and in 2006. These two events coincided with the building of a sewer network and treatment plant in Contulmo (i.e. ESSBIO treatment plant, also considered a key factor determining the eutrophication of the lake), and the harvest and fertilization process of eucalyptus plantations within the catchment of the lake (Comisión Lago Lanalhue, 2007; Dècle & Maignan, 2006; Bardón, Cienfuegos & Sperberg, 2006). Besides the ecological dimension and

related issues, this burst in presence of luchecillo has created problems within the tourism industry (i.e. economic dimension), and for the recreational use of the lake by community members and visitors (i.e. social dimension) (Etchepare & Furet, 2008; Lanalhue Sustentable, 2011). How and when exactly this aquatic plant arrived to the lake is unknown, with different theories and local myths regarding this issue.

Figure 5.3. Presence of luchecillo (*Egeria densa*) in the Lanalhue Lake.

Some argue that it arrived on a recreational boat; others say it was brought to the lake by black-necked swans, which arrived around 2003-2004 in large numbers to the lake (i.e. approx 2500 individuals), “escaping” from an ecological disaster at their previous habitat (i.e. the pollution of the waters of the Cruces River by a Cellulose plant 350 km South, near the city of Valdivia). Other local people argue that the luchecillo has always been in the lake in a dormant state and in low numbers (Lanalhue Sustentable, 2012).

Since the proliferation of the luchecillo, this socio-ecological issue has become a major concern for local people (Bardón et al., 2006; Comisión Lago Lanalhue, 2007). Local authorities have worked on different plans and measures to address this issue (i.e. especially during the periods 2006-08, and more recently during the period 2012-2013), including the proposition of a range of short, middle and long-term measures (Etchepare & Furet, 2008; Lanalhue Sustentable, 2012). Nonetheless, and according to some local views, in the great majority of cases these

measures have not seen light principally due to political and bureaucratic factors, lack of sustainability leadership, or because of an evident lack of ecological literacy both between local authorities and between community members (Comisión Lago Lanalhue, 2007; Lanalhue Sustentable, 2012).

Another issue with the luchecillo and black-necked swans is that swans use the luchecillo as their principal source of food, this being one of the reasons why many of them have chosen this lake as their new habitat. Local people and the tourism industry took the arrival of the swans as a new natural and tourist attraction, and many people had positive attitudes towards them (Ortiz & Arrey, 2007; Pérez, 2009). However, some people argue that the presence of luchecillo is the swans' fault, with consequent negative attitudes towards them (Lanalhue Sustentable, 2011). In general terms, it seems that the majority of people want the swans to stay, but the luchecillo to disappear.

One last issue regarding the luchecillo is that it is known to experts that if it is approached without an effective management plan, based on scientific research, it is highly probable that Cyanobacteria (i.e. microorganisms related to bacteria capable of photosynthesis) will take its place, meaning a greater deterioration of the local ecosystem, which could involve a potentially significant impact for the local community in recreational, social, and economic terms (Mazzeo, 2005).

Other sustainability issues identified during the planning phase that are present in the context of the Lanalhue Lake are the following:

- Presence of invasive pest plants (other than luchechillo);
- Animal pests, e.g. presence of rabbits eating native plants, or wild dogs displacing the highly endangered Darwin's fox (*Pseudalopex fulvipes*);
- High levels of rubbish littering;
- Rubbish burning with consequent air pollution;
- Lack of soil use regulations and consequent unsustainable practices;

- Water pollution, e.g. washing cars close to, and even in the lake;
- Presence of cattle by the lake;
- High presence of motorboats during summer time with consequent water and noise pollution;
- Unauthorized camping by the shores of the lake.

One way or another, all these factors may contribute directly or indirectly to the overall socio-ecological sustainability of the area, and many of them to the process of the accelerated eutrophication of the lake.

In summary, there is a range of environmental and sustainability issues that can be related to a lack of an ecological sustainability culture in the area that affects both the quality of the ecosystem, and the quality of life of local community members and visitors.

5.2.1.1 Education for sustainability at Lanalhue Lake

Based on observations and informal interviews with local community members and key strategic individuals carried out during the planning phase, it seems that the ecological dimension at Lanalhue Lake has not been taken into consideration by local authorities. There are some recently established ecological and environmental groups within the area that have been asking for more action to address ecological problems from local authorities. In addition, there was the feeling among interviewees that there is a growing interest and awareness on the part of the local community in relation to the wellbeing of their natural environment, including growing concerns for the ecological deterioration of the Lanalhue Lake, but that local authorities do not prioritize environmental concerns in general. For example, one of the interviewees reported during the pre-intervention phase:

> Today there is more interest from the local community in general. Before there was not such interest, but today there is interest and that helps a lot. (…) Local authorities need to get involved and start taking action. One thing is to talk nicely and understand the problem, another thing is to get involved and engage into action!
>
> (Ronald, local expert, pre-design research phase)

Generally, as reported in the literature, levels of awareness of sustainability issues are higher than the levels of knowledge and understanding at the general public level (Orr, 2004; Oulton & Scott, 2000; Sterling, 2001). This also seems to be the case at the Lanalhue Lake in Chile. It seems that within the local community there is a general lack of understanding of socio-ecological sustainability issues affecting the Lanalhue Lake, but a high level of awareness of the existence and presence of the luchecillo in the lake (Ananías, 2013). Similarly, EE and EfS programs, both at the formal and non-formal educational levels, are almost non-existent in this area. Only some recent and isolated initiatives from some local and regional environmental organizations (e.g. Red Contulmo, CODEFF) (Comisión Lago Lanalhue, 2012; Lanalhue Sustentable, 2012; Pérez, 2009), such as educational seminars and planting days for schoolchildren, are EE-related activities that can be found within the community.

In terms of the educational approach for the EfS website planned for this local context, ideally it should address all key aspects related to the accelerated eutrophication of the lake, and also include ecological literacy-related aspects to educate about, for example, rubbish littering, knowledge on native biodiversity, conservation biology issues and perspectives, and guides on sustainable principles and practices that can be adopted to minimize the social impact on the lake (e.g. control of sewage waters around the lake). Nonetheless, the final structure and contents of the EfS website was determined by the information collected during the pre-design research phase, and by logistics-related factors (e.g. funding available).

In addition, and based on the theoretical model, other related and non-related issues should also be part of the EfS website, with the aim of providing an holistic picture associated with the accelerated eutrophication process existing at the lake, and to principles and practices related to sustainable living. Nevertheless, the main issue to be addressed in the EfS website is the water quality and eutrophication issues of Lanalhue Lake, as these seemed to be the most worrying and relevant issues for

local authorities and community members at Lanalhue Lake. More on the educational components of the EfS website addressing the Lanalhue Lake context follow in the coming sections.

In general Chile is characterised by having an ICT and Internet penetration across the country (ADOC, 2011; Donoso & Roe, 2006; Everis, 2011), being recognised as the leader in ICT development and penetration in South America (ITU, 2012). Despite the high levels of poverty and vulnerability reported for the area around Lanalhue Lake, the target community is not an exception to these high levels of ICT penetration. In general terms, the ICT and Internet penetration within the local community is such that it satisfies the theoretical model's requirement in terms of the conditions to choose a target community for the use of EfS websites (see Section 3.3.1).

5.2.1.2 Information on general experts

During the planning stage of the intervention, eleven different general experts from strategic organizations related to EfS and ICT in Chile were contacted and invited to provide input to this study. General experts from EfS were mainly from academic institutions, and government agencies related to education for sustainability (e.g. Corporación Nacional Forestal). Regarding ICT experts, some of these were related to academic institutions, in particular experts in the area of ICT and education in Chile; and others were individual professional experts on web design and development. Informal interviews carried out with these experts consisted of general open-ended questions that aimed to explore and identify general issues related to EfS and to ICT in Chile. Such information contributed to the selection of the target community of this study.

5.2.2 Summary

In this section a brief description and characterisation of the local socio-ecological context and sustainability issues affecting the target community was presented. The objective of this section was to familiarise the reader with the main sustainability issues affecting the local community at

Lanalhue Lake. As mentioned at the start of this section, the accounts presented here were mainly based on data collected during the planning phase of the model for developing EfS websites. Such data collection included observations, informal interviews with local people and key individuals of the community, and the review of some existing documentation regarding the eutrophication process at Lanalhue Lake (i.e. principally review of local newspapers and information obtained at the local councils).

This early phase of the process of developing an EfS website, as recommended by the theoretical model, aimed to collect the necessary information to evaluate the potential, and contextualize the design and use, of an EfS website by the target community. The information retrieved during this early phase also allowed the planning and preparation of the second phase from the theoretical model. This is the pre-design research phase, where a deeper understanding of the local socio-ecological context was achieved through a series of data collection methods and instances. More detail on this pre-design research phase follows in the next section.

5.3 Pre-design research phase

In this section the data collection process of the pre-design research phase is presented and described. This phase included four research stages where data was collected (for further detail on these research phases see Section 4.5.2):

- Stage 2a: Interviews and document analysis to understand the local context, characteristics and needs;
- Stage 2b: Questionnaire survey on existing sustainability conceptions;
- Stage 2c: Questionnaire survey on ICT, Internet and websites preferences;
- Stage 2d: Interviews and document analysis addressing the local socio-ecological sustainability issues

The objective of these stages was to obtain all the necessary information and materials to support the development of the EfS website *Lanalhue Sustentable* during the design phase. Such information included an understanding of local existing sustainability conceptions and ICT preferences, in order to guide the development the EfS website. Two questionnaires were designed and administered among local community members (i.e. Stages 2b and 2c), through direct invitation in public areas. Moreover, information regarding the socio-cultural and socio-ecological contexts was also required as part of this pre-design research phase, for which a series of interviews and document analysis were carried out (Stages 2a and 2d). In addition, another key objective of this pre-design research phase was to gather materials that could be included as part of the content of the EfS website, such as photos, publications and documents, or just relevant antecedents and information that may assist the design process of the EfS website and its contents.

In the next two sections, the data collection methods and findings of this phase are presented, including some analysis and interpretation of the data collected in terms of the theoretical model. The issues related to the data collection and interpretation regarding the local characteristics of the target community during the pre-design research phase follows.

5.3.1 Data collection

This pre-design research phase was framed around the information retrieved during the planning phase of the development of the EfS website *Lanalhue Sustentable* (Section 5.2), as well as the logistics of the present intervention. Besides the achievement of an understanding of the social, cultural, ecological and local context characteristics and needs, which was achieved through interviews and document analysis, this pre-design research also intended to retrieve crucial information for the development of meaningful and relevant EfS website affordances. Table 5.1 is a reminder of the characteristics of the data collection stages carried out during the pre-design research phase of this intervention.

Table 5.1. Data collection stages, objectives, methods and associated issues of the pre-design research phase.

Research Stage	Objective	Methods	Sample (n) *
2a. Understanding of community's contexts	Input from key strategic persons, organizations and groups, in order to understand the context of the target community in relation to the chosen sustainability issue.	Interviews Document analysis	11
2b. Assessment of existing conceptions	Survey of community members to assess their existing conceptions regarding local sustainability issues.	Questionnaire Survey	19
2c. Website preferences evaluation	Survey of community members regarding websites preferences to determine which website features and affordances appear to be relevant and meaningful to community members.	Interviews Questionnaire Survey	19
2d. Understanding of sustainability issue	Input from strategic persons, experts, organizations and groups to understand the sustainability issues of the target community.	Interviews Document analysis	11

(*) Note that the sample (n) corresponds to interviews and questionnaire surveys. All participants were recruited by invitation; for stages 2a and 2d this was done through networking; for stages 2b and 2c recruitment also included public advertisement.

According to the model for the development of EfS websites (see Chapter 3), understanding the range of existing conceptions regarding local sustainability issues among the target community, as well as understanding the existing preferences and type of use of ICT in the

community, are key aspects that can influence the development of meaningful affordances. In the context of the Lanalhue Lake, these two aspects were evaluated through the design and administration of two questionnaire surveys within the target community (see Section 4.5.1, and Appendixes B and C for details on the questionnaires).

In terms of activity theory (AT) presented in Chapter 4 as an analytical framework for the present intervention, Engeström's activity system model (see Figure 4.1) considers the entire social system beyond individual learners, accounting for the environment, history of the learner, culture, role of the mediating tool (i.e. the EfS website in the context of the Lanalhue Lake activity system), motivations, complexity of real life actions, and social structures (Cole & Engeström, 2001; Kaptelinin, 1995).

All research stages from Table 5.1 were designed and analysed in consideration of the views of activity theory, in terms of accounting for the overarching components that determine the activity system in the context of Lanalhue Lake. In practical terms, the design of the data collection instruments from Table 5.1 intended to account for each one of the components of Engeström's activity system model (i.e. community structure and historicity, division of labour, social rules, and background of individual learners).

As suggested in the literature, as well as in the theoretical model for the development of EfS websites, an in-depth understanding of the local, social, cultural, and ecological contexts of the target community in relation to the chosen sustainability issue is essential for the development of meaningful and locally relevant EfS websites aimed at the community level. Within an activity theory lens, and through the achievement of the data collection stages and associated objectives presented in Table 5.1, this pre-design research phase informed the design team of the EfS website Lanalhue Sustentable on different aspects related to the socio-ecological and technological (i.e. type of ICT use) characteristics and needs of the target community. In the coming subsections, a brief

description of the purposes and expected outcomes of the research stages from Table 5.1 follow.

5.3.1.1. Understanding of the socio-ecological characteristics and needs of the target community

Research Stages 2a and 2d were designed to assess the social, cultural, ecological and local context characteristics and needs of the community associated with the Lanalhue Lake in Chile. The data collection methods for these two stages included document analysis, and interviews with key strategic individuals from a diverse range of community organizations, NGOs, and local Council departments who were knowledgeable on the issues addressed in the EfS website *Lanalhue Sustentable*. Note that these individuals were identified and contacted through the networking and partnership carried out during the planning phase, as recommended by the theoretical model from Chapter 3. Table 5.2 provides some background on the local experts that participated of research Stages 2a and 2d.

Table 5.2. Characteristics and background of local experts interviewed during the pre-design research phase (n = 11; research stages 2a and 2d).

Local expert ID	**Organization / Occupation / Background**	**City**
2a1	School teacher, environmental expert	Contulmo
2a2	Tourism Office, local Council	Cañete
2a3	Local Environmental Authority Office	Cañete
2a4	Environmental Office, local Council	Cañete
2a5	Local expert and strategic person	Cañete
2a6	Local expert and strategic person	Cañete
2a7	Environmental Office, local Council	Contulmo
2a8	Ecotourism Operator, local expert	Contulmo

2a9	Mapuche Culture expert	Contulmo
2a10	Mapuche Culture expert	Cañete
2a11	Local environmental NGO expert and leader	Cañete

A good understanding of the local characteristics allows the design team to guide the design and development of the content and affordances of the EfS website *Lanalhue Sustentable*. As highlighted in community education literature, some guidelines to achieve such understanding of the target community implies spending time in the community, informally and formally to talk to people about their views of the existing sustainability issues within the community, and to try to get the feeling of the local issues and critically understand them (Thompson, 2002).

Such an approach for the understanding of the local context was adopted in the context of the Lanalhue Lake. As the researcher I spent several months living in this community during the year 2010, and had the chance to interact with many local people and ask their opinions and views about the lake. In addition, and as mentioned earlier, formal interviews were carried out with key strategic individuals from the community. Such involvement within the local community allowed me as the researcher to get a good feeling of the issues related to the sustainability of the Lanalhue Lake. At some point the views and perspectives of local members started to repeat themselves, which in my personal judgement was an indication that the main issues were covered, and that an understanding of the characteristics and needs of the local community was achieved. Data regarding these stages 2a and 2d is presented below in Section 5.3.2.3.

5.3.1.2 Understanding of existing conceptions in the target community

According to the theoretical model for developing EfS websites, the assessment and understanding of the range of possible existing conceptions related to the chosen sustainability issue is important in order to design and develop meaningful EfS websites for the target community.

Such assessment also allows the identification of alternative conceptions and to directly address them during the design phase, for example, by challenging existing alternative conceptions and beliefs by means of a true and false list of facts regarding the lake.

As mentioned in Chapter 2, when learners are faced with new information, they actively and subjectively generate their own knowledge by either accommodating (i.e. adapting) their own cognitive structure, or by assimilating information, in order to fit it in their current worldview (Kelly, 1991). Based on the tendency to stability of conceptual structures on learners, Menzel and Bögeholz (2008) indicate that prior established knowledge and ideas might be an obstacle for the acquisition of new information and knowledge related to sustainability issues. Therefore, by being aware of the cognitive framework (i.e. conceptual structure) of learners, educational interventions "can actively address prior existing cognitive frameworks to enhance the learning process" (Menzel & Bögeholz, 2008, p.431). In order to achieve understanding of the existing local conceptions, the questionnaire survey 2b was designed using a series of questions dealing with perspectives regarding the local sustainability issues.

Another objective of survey 2b was to assess the level of knowledge of community members in regard to Lanalhue Lake's sustainability issues. The assessment of the level of knowledge allowed the design team to target the development of particular types of content and affordances based on the identified needs of the target community. For example, understanding the general level of knowledge about the sustainability issues occurring at Lanalhue Lake permitted an informed choice of the desired intensity, sophistication and depth of information to be included in the EfS website. In summary, the aim of survey 2b was to assess community members' level of knowledge associated with the sustainability issues present at Lanalhue Lake, and the quality of such knowledge, in terms of the type of existing conceptions regarding such sustainability issues. Data from this survey is presented below in Section 5.3.2.1.

5.3.1.3 Target community's website features and affordances preferences

Based on the theoretical model for developing EfS websites, the objective of survey 2c was to assess local community members' ICT and Internet skills, and preferences for different types of website features and affordances (e.g. text format and length; use of pictures, videos and/or animations; accessibility preferences, etc.). This was based on theory from the model for developing an EfS website, under the notion of obtaining input from end users of ICT tools, i.e. local members of the community, within a user-informed design framework (Facer & Williamson, 2004). This means the involvement of end-users in the design and development of the EfS website to assist the development of culturally relevant EfS affordances (see Section 2.4.3).

As mentioned in Section 2.4 of the literature review, a large body of research stresses the importance of the social context and the understanding of the cultural needs in the shaping of Internet-based materials, in order to generate culturally meaningful websites (Kling, 2000; Knight et al., 2009; Selinger, 2004; Woo, 2009). Such understanding of the characteristics of the target community regarding the use of websites should be part of a 'pre-design research' process, as advocated by Knight et al. (2009) and Facer & Williamson (2004).

In the case of the present study, this was principally achieved through survey 2c addressing website preferences at the local community level by means of a questionnaire and a short interview. Following the questionnaire, participants of this survey were invited to review three different types of websites on a laptop computer: an old fashioned first generation website (i.e. Web 1.0 website), characterized by having mostly plain text; a Web 2.0 website, with clear social media and networking sections on it, and some multimedia aspects; and a highly animated and dynamic website, with many multimedia affordances shown on its home page. Here participants had to indicate their preference for each type of website, and explain why they made such a choice and what website aspects were most attractive to them.

This interview provided valuable information in terms of ICT preferences at the local level that assisted the design phase of the EfS website *Lanalhue Sustentable*. For example, the highly animated type of website shown during the interview required a better Internet broadband connection than the other two type of websites. This was noticed by some participants and discussed with the researcher. In some parts of the local community, available Internet broadband speed was slow, which affected the loading time of the highly animated website. Some participants reported here that they liked such websites in terms of their dynamism, but that local Internet conditions would represent an obstacle for its normal use. This outcome from survey 2c regarding websites preferences influenced the design team of the EfS website Lanalhue Sustentable to avoid such type of Internet broadband-dependent animated affordances, and to focus on Web 2.0 affordances and other types of multimedia affordances (i.e. photos and videos). Data from this survey is presented below in Section 5.3.2.2.

5.3.2 Data analysis and interpretation

In this section data collected during the pre-design research phase is presented. Based on the findings inferred from this data, some analysis and interpretation of the data is also presented at the end of the data presentation. Such analysis and interpretation of data is done within the framework of the theoretical model for the design of EfS websites, presented in Chapter 3, and in consideration of the activity theory (AT) analytical framework presented in Chapter 4. This section is organised in terms of the research stages carried out during this pre-design research phase, as presented in Table 5.1. Firstly, data from survey 2b assessing the existing conceptions regarding sustainability issues at Lanalhue Lake is introduced. Then follows the presentation of data from survey 2c 'Websites preferences'; and finally, data from research stages 2a and 2d, aimed at understanding the local socio-ecological characteristics and needs of the target community is presented.

Note that data is presented in a raw format style, in order to provide the context of the surveys in terms of the questions and type of answers. For

the interviews, data presented corresponds to the most recurrent answers from participants. In terms of the analysis, these are included at the end of each subsection, and are characterised by being a first level type of interpretation and analysis. Further analysis and interpretation of data is shown in Section 5.4, where a framework for the development of the EfS website *Lanalhue Sustentable* is presented based on theoretical aspects from the model, and on data presented in this section. Data from the pre-design research phase follows.

5.3.2.1 Survey 2b 'Existing sustainability conceptions'

The following list summarizes relevant findings from survey 2b 'Existing sustainability conceptions'. Note that while 19 local community members from the area of the Lanalhue Lake were invited and recruited to participate in survey 2b; not all participants answered all the questions:

- When asked their attitude or opinion towards Lanalhue Lake (Q5), 16/19 participants indicated a positive response, and only one indicated a negative response. This indicates that there may be an overall positive disposition towards the lake amongst the local community.
- Most participants (12/16) felt that Lanalhue Lake was not a healthy environment (Q6). The main reasons given for this belief were that waters of the lake are polluted from anthropogenic factors.
- When asked to identity one to three environmental problems present in the area (Q7), the five most indicated problems and issues from 16/19 participants were: (1) presence of exotic aquatic plant (luchecillo) (10/16); (2) polluted waters (8/16); (3) pollution from Forestry industry (6/16); (4) dirty environment (4/16); and (5) pollution from motorboats (4/16).
- When asked about the type of information they would like to know about the Lanalhue Lake (Q8), 9/19 participants provided answers with a tendency regarding issues related to: the causes of eutrophication; the real environmental state of the lake; general characteristics of the lake (e.g. origin, depth and biodiversity); guidelines about what to do and how to contribute to eutrophication

minimization, including short, mid and long term solutions; and reliable scientific information regarding the eutrophication of the lake.

- Question Q8b then followed up the previous answers by asking the preferred source of information regarding the Lanalhue Lake, and the most indicated source was the Internet with 7/9 participants reporting it, followed by local newspaper, books, publics seminars, and the local council, each one of this with one mention. Note that two participants indicated: “I don’t have the opportunity to get information”, and this suggests a lack of sources of information to some members of the local community.

Regarding the existence of alternative conceptions held by participants, answers to Q7 permitted to identify the following alternative conceptions held by participants (16/19):

- *“*There are no environmental / sustainability problems at all”
- “There are no people responsible for the process of eutrophication, it is nature’s way to do things”
- “Luchecillo is an algae” (i.e. is not an algae, it’s an aquatic plant)
- “Luchecillo is due to swans’ fault” (i.e. the appearance of luchecillo is not, the dissemination of it is)
- “Luchecillo pollutes the water” (i.e. luchecillo is not a pollutant, but a consequence of pollution)

In summary, survey 2b provided relevant information regarding the aspects that seemed to be meaningful and relevant to participants regarding sustainability issues at Lanalhue Lake. Data from survey 2b indicates the following:

- Attitudes towards the lake in general were positive
- Participants’ appreciation of the environmental state of the lake indicated the common belief that the lake is not a healthy environment, in particular, that its waters are polluted.
- The most recurrent alternative conceptions regarding the sustainability of the lake are related to the luchecillo. In particular,

that this plant is an algae; and that the luchecillo pollutes the water (it actually helps to clean the lake by producing biomass from nutrients). In addition, there is a strong belief within some of the participants that the swans brought the luchecillo to the lake, which has not been proven.

- Participants reported they would like to know about a range of information and issues related to the general characteristics of the lake and to the eutrophication process of the lake.

The data obtained through survey 2b informed the design process of the EfS website in many aspects. For example, alternative conceptions were addressed and targeted in a 'frequently asked questions' section of the website. Information regarding the design and development of the EfS website follows in Section 5.4. The next section presents relevant data from survey 2c addressing ICT and website preferences.

5.3.2.2 Survey 2c 'Website preferences'

The following list of questions from survey 2c 'Website preferences' presents a summary of relevant data considered important to inform the development of the EfS website *Lanalhue Sustentable* (n = 19):

- When asked to self-report on their expertise and knowledge on the use of computers (Q4), 12/19 participants reported an average knowledge, with the remaining 7/19 participants indicating a very good to excellent knowledge about computer use. A similar result was found in Q5, where participants had to report on their knowledge of use of the Internet.
- When asked about their access to the Internet (Q6), 16/19 participants indicated they had access whenever required, with the remaining 3/19 participants reporting access to the Internet only 'sometimes'.
- The majority of participants reported in Q9 that they would use a website addressing the environmental and sustainability of the Lanalhue Lake. When asked about their preferred sources of information regarding issues related to Lanalhue Lake (Q10),

participants reported the following: Experts (n = 13/19); Local council (n = 9/19); Academic literature (n = /19); Indigenous Knowledge (Mapuche) (n = 8/19); Local media (n = 7). In addition, one participant answered under 'other option' that examples from other countries would be good, as a way to compare the Lanalhue situation with other similar experiences.

- Regarding their preferred type of website (QA&B; websites type 1, 2 or 3 as described in Section 5.3.1.3), 12/19 participants indicated their preference for the Web 2 type characterized by the use of Web 2.0 and social media features; 3/19 participants indicated the Web 3 type characterized by being highly animated; and 4/19 indicated a combination of website types 2 and 3. Note that many participants declared that, although they do prefer website type 3, but because of Internet speed available locally they marked type 2 or a combination of type 2 and type 3, as type 3 take longer to load within some places in the local community.

Survey participants were asked to rank in descending order the aspects / features that they would like to see in a website addressing sustainability issues in places like Lanalhue Lake (Q11). Responses to this question are shown in Table 5.3. The most indicated website feature was the inclusion of news regarding the place (e.g. Lanalhue Lake), with 16/19 participants indicating that option. This was followed by both videos and pictures, which can be grouped under 'multimedia features', indicated by 14/19 participants.

Data collected from survey 2c suggests that:

- Most participants rate themselves 'average-to-good' in ICT and Internet competence and skills, in terms of the local context, and of the Chilean context.
- Participants indicated in general a good access to computers connected to the Internet.

Table 5.3. Participants' ranking of aspects/features that they would like to see in a website addressing sustainability issues in places like Lanalhue Lake.

Website Feature	Ranking			
	Total times indicated	**Times first**	**Times second**	**Times third**
News regarding place and issue e.g. the Lanalhue lake	16	4	5	4
Videos	14	3	2	6
Pictures	14	6	2	3
Maps of the area e.g. water bodies related to the Lanalhue lake	11	4	4	1
Text information	10	4	1	1
Links to similar / related websites	10	2	2	0
Information on 'what to do' / 'where to go' regarding environmental / sustainability issues	10	3	1	2
History related to the place and issue e.g. Lanalhue lake	9	4	2	0
Animations	7	1	0	1
Diagrams	7	0	0	3
Links to Facebook, Twitter, and similar social networks	6	1	0	0
Comments section	6	1	3	1
Blog section	3	0	2	1

- Participants would visit an EfS website addressing sustainability issues present at Lanalhue Lake, which suggests that it is a meaningful issue to them.

- Locally-based information (i.e. local council and local media), objective and technical information (i.e. academic and experts), and Mapuche-based information are the most preferred sources of information to surveyed participants, regarding issues related to the sustainability of Lanalhue Lake.
- A mixture between websites type 2 and type 3 (i.e. Web 2.0 and highly animated and graphical types of websites) would be appropriate for participants. Data includes reported interest in multimedia features (principally photos, videos, text and maps); news regarding the lake; links to similar websites; history regarding the lake; and practical guidelines on 'what to do' or 'where to go' in relation to sustainability issues present at the lake.

As a general overview, it can be argued that this data was important to inform the type of EfS website that would be meaningful for local community members and to the local context, in terms of the website features and affordances to include. Nonetheless, this data needed to be analyzed in combination with other data collected during this pre-design research phase, as well as with theoretical considerations from the model for developing EfS websites. In the coming subsection, relevant data from interviews 2a and 2d addressing socio-ecological and socio-cultural characteristics and needs of the target audience are presented.

5.3.2.3 Data from surveys 2a and 2d addressing socio-ecological characteristics and needs of the target community

In this subsection, relevant data from interview surveys 2a and 2d are presented. Note that in many cases interviews that were aimed at retrieving information on issues related to the sustainability of Lanalhue Lake (survey 2d) also provided information on the target community's local, social and cultural contexts, characteristics and needs (objective of survey 2a). The participants of these interviews, considered in this study to be key strategic individuals from the local community, were identified and recruited through networking and partnerships carried out during the planning phase of the development of the EfS website Lanalhue

Sustentable. The following data is a summary of relevant information retrieved from the interviews regarding the socio-ecological context of the target community.

I. General overview of sustainability issues present at Lanalhue Lake

Participants' views of sustainability issues at Lanalhue Lake included a variety of aspects and elements, mostly related to the eutrophication process. These aspects were grouped under five main aspects presented below:

1. Waste/pollution - littering, burning and lack of sustainable management (tourists & residents); acoustic contamination (motorboats, chainsaw, forestry trucks); forestry industry pollution and water contamination; use of agrochemicals and pesticides from part of agriculture and forestry industries.
2. Water – lack of sewage network, and of regulations by councils; dumping of contaminants to the lake (directly or via water streams); alteration of natural ingoing water streams within the catchment of the lake (consequent loss in water quality for human consumption and home-based agriculture).
3. Land use – loss of native forest and local biodiversity by new cottages and forestry industry, and by illegal hunting/logging.
4. Issue management – lack of environmental regulations; cottage proliferation without soil, waste, or building regulations; lack of concrete actions by local authorities; lack of leadership regarding the sustainability of the area; massive tourism growth during the last 20 years, increasing anthropogenic effects on the lake.
5. Information/knowledge - lack of ecological literacy; information access problems and issues for community members; loss of Mapuche cultural practices and knowledge.

II. Identified sustainability issues related to the eutrophication process and proliferation of Egeria densa at Lanalhue Lake

Below is presented a summary of aspects related to the eutrophication process of the lake, reported by participants of surveys 2a and 2d. In

particular, these aspects were grouped under ‘contributors of eutrophication’ and ‘consequences of eutrophication’:

a. Contributors to the eutrophication:

1. Waste/pollution - sewage water plant at Contulmo that contributes directly to proliferation of luchecillo: evident alterations after the first year of operation in 2002; car and truck washing by the lake with use of detergents, oil pollution; use of agrochemicals and pesticides by agriculture and forestry industry
2. Natural factors - lake’s shape and depth at Contulmo side: contributes to high density of luchecillo in that area compared to the rest of the lake; presence of Contulmo town by the lake; slow renewal rate of Lanalhue Lake’s waters; decrease in rainfall levels during the last decades, thus affecting the renewal rate of the lake’s waters; increase of lake’s sedimentation process: contributes to luchecillo proliferation; negative effects in water output; swans arrived massively in 2004; contribute to distribution of the luchecillo
3. Anthropogenic factors - motorboats: contributes to disseminate luchecillo; pollute water; acoustic pollution; modification of water streams; increase in holiday cottages and residential homes by the lake without sanitary regulations in the past years
4. Issue management - lack of environmental / sustainability-friendly development plan for the lake; no management plan for luchecillo once harvested (by new aquatic harvester machines); presence of cattle by the lake: during winter lakes varies between ± 3-5 metres, and rainwater washes in organic materials from cattle.

b. Consequences of the eutrophication and related issues:

1. Ecological consequences - decrease in number of native fish fauna; luchecillo modifies natural levels of oxygen in the water of the lake: negative effects for lake’s biodiversity and natural ecosystem; increase in number and species of aquatic birds.
2. Social issues - incongruence between existing studies addressing the eutrophication of the lake: obstacles for community members to have an informed opinion.

III. Relevant information / content to include in the EfS website Lanalhue Sustentable

Participants of surveys 2a and 2d also provided their perspectives on the topics that they considered pertinent to include within an EfS website addressing the context of the Lanalhue Lake. Below follows a summary of the key points and issues highlighted by participants during the pre-intervention interviews:

1. Education - educate about existing biodiversity; about lake's hydrodynamic characteristics; educate about newly arrived aquatic harvesting machines (two hi-technology aquatic harvester machines from Canada); issues related to increase of holiday cottages: negative effects and unsustainable practices; educate about possible sustainable practices to adopt in context of Lanalhue Lake; educate about Mapuche's worldview regarding the natural environment, the relationship between humans and nature, etc. (indigenous knowledge); acknowledge importance of Mapuche culture for the local, social and cultural context of the lake.
2. Information/knowledge - compare with other countries or similar experiences; information regarding black-necked swans; forestry industry: history, effects; general information regarding the lake's characteristics; provide range of possible urgent, short, mid, and long-term solutions and possible scenarios regarding Lanalhue Lake; include high amount of information, studies, documents, links, etc., relevant to the context of Lanalhue Lake
3. Luchecillo related issues - information about use of luchecillo in aquariums; general information regarding all aspects of eutrophication of lakes and of luchecillo.

Overall, data collected through interviews with key strategic individuals of the target community contributed to achieving the objectives of the pre-design research phase: to achieve an understanding of the local, social and cultural contexts of the target community, as well as to understand the sustainability issues related to the lake. In consideration that the data obtained through the pre-design research phase was provided by local

community members, and that the research instruments were developed to address and understand the local context, it can be said that the information obtained can help to inform the design and development of a locally-relevant and meaningful EfS website for the target community.

5.3.3 Summary

As a summary of this section addressing the pre-design research phase of the model for the development an EfS website in the context of the Lanalhue Lake in Chile, an understanding of the social, cultural, local and ecological context of the target community was achieved. The administration of the surveys among local community members acting as participants in this pre-design research phase provided valuable information and data to inform and guide the design and development of the EfS website *Lanalhue Sustentable*. In moving on to the design phase, a critical point of this design process was to achieve an effective integration of the theory from the model with data collected during the pre-design research phase. This was in order to develop a culturally relevant and meaningful EfS website.

The coming section presents the process of integration of theoretical considerations with the data collected during the pre-design research phase, in the form of a framework for the development of the EfS website *Lanalhue Sustentable*.

5.4 Design and development of an EfS website in the context of the Lanalhue Lake

This section presents the application of the theoretical model for the development of EfS websites in the socio-ecological context of the Lanalhue Lake in Chile. It presents the application of the model in the context of the accelerated eutrophication process occurring at Lanalhue Lake. The first part reviews a framework for the development of an EfS website in the context of the Lanalhue Lake. This framework is based on theoretical considerations, and on data collected during the pre-design research phase, and explores the combination of these two sources of

information to inform the design process of an EfS website in the context of the Lanalhue Lake. The second part of this section presents the EfS website *Lanalhue Sustentable*.

5.4.1 A framework for the development of an EfS website in the context of the Lanalhue Lake

According to the theoretical model from Chapter 3, there are nine key EfS-related pedagogical dimensions and approaches to include within an EfS website (see Table 3.2). Five of these pedagogical approaches relate to the concept of ecological sustainability defined in Section 2.2, which are transformative learning, systems thinking, ecological literacy, long-term thinking, and ethical principles and values. The other four pedagogical approaches are critical thinking and political literacy, both crucial in community EfS; and the promotion of understanding and action, in relation to socio-ecological sustainability issues. These nine EfS-related pedagogical approaches were presented in Table 3.3, illustrating their role in the learning process associated with the use of EfS websites at the community level, where the final aim is to promote both understanding and action around socio-ecological sustainability issues at the community level.

In this section, each one of these nine pedagogical approaches are briefly put into the context of the identified characteristics and needs of the target community. This is done based on data collected during the pre-design research phase, and focusing on the type of website features and affordances that may implement such locally rooted pedagogical considerations into the EfS website *Lanalhue Sustentable*.

At this point, a key epistemological consideration in regard to EfS websites is important to recall. As argued earlier in this thesis, a systems thinking approach has been adopted for the development and use of the EfS website *Lanalhue Sustentable*. This includes some systems thinking perspectives, presented in Table 3.1 of Chapter 3 that should underpin the design, development and use of an EfS website at the community level.

These systems thinking perspectives relate to the design of the EfS website in terms of creating an educational system which operates as a learning facilitator, where the promotion of coupling and interaction between learning actors, as well as the consideration of the learning context, are crucial for learning. Within such a view, some scholars argue that cognition does not occur in individual minds but in the possibility of shared actions, where learning and knowledge are emergent processes that arise beyond the solitary cognising agent that is part of an increasingly complex system (Cole & Engeström, 2001; Morrison, 2002; Sumara & Davis, 1997).

As presented in Chapter 4, activity theory (AT) provides theoretical guidelines that account for the entire system beyond individual learners, as well as for learner's conceptions, motivations, backgrounds and needs that accommodate an epistemological view based on systems thinking and complexity theory in education. From an AT perspective, people are socially-culturally embedded actors, which calls for accounts of the entire social and cultural contexts of the person and the larger community, their developmental history, role of available set of artefacts, and complexity and dynamism of real life situations and actions (Cole & Engeström, 2001; Kaptelinin et al., 1995).

Using Engeström's model of an activity system adopted in the context of the activity system at Lanalhue Lake, the EfS website as a facilitator can be seen as the tool that mediates the learning process for community members towards the expected goals of the system, which are to promote understanding and action around local sustainability issues. Figure 5.4 illustrates this adaptation of Engeström's model in the context of the use of an EfS website for community education at Lanalhue Lake. In this activity model, the EfS website is situated at the top of the educational activity system, which in turn is determined by the other components of the local system (based on Cole & Engeström, 2001).

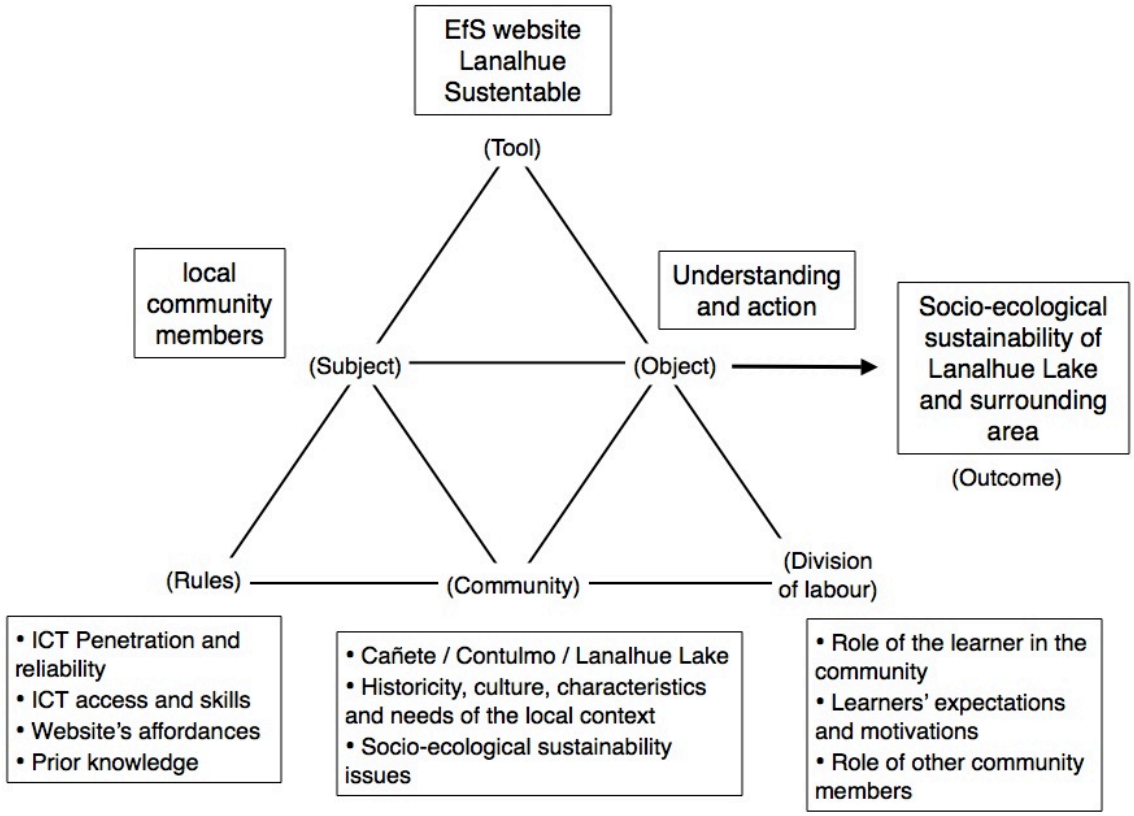

Figure 5.4. Adaptation of Engeström's model of activity system in the context of the Lanalhue Lake educational activity system.

Consideration of the educational system underpinned by the EfS website *Lanalhue Sustentable* as an activity system is helpful as a guiding principle and theoretical framework for the design of a culturally meaningful EfS websites, while accounting for the entire overarching set of relationships influencing the associated learning process on individual learners. As represented in Figure 5.4, the expected outcome in the Lanalhue Lake educational activity system is to promote understanding and action regarding existing sustainability issues. According to this model, a learning experience occurs (i.e. the 'object') through the use of the EfS website (i.e. the 'mediating artefact'), which in turn is dependent and influenced by the particularities, set of rules, and division of labour (i.e. community structure) of the local milieu.

One question that the design team had to address was how to promote learning in such an educational activity system based on an EfS website? From the perspective of complexity theory in education, this could be

achieved by ensuring the presence of key conditions for the creation and nurture of educational systems, such as through:

- Promoting means for components to affect each other (i.e. enhance interactivity)
- Familiarity with the learning issue;
- Enabling expression of diversity;
- Mechanism to prompt ideas to interact;
- Decentralized type of control.

(Davis & Sumara, 2005).

As stated in the theoretical model, the above conditions can be addressed through an EfS website, for example, by maximizing the website's affordances and interactivity tools (e.g. use of multimedia and Web 2.0 features), by being aware of the characteristics of local, social and cultural contexts of the target community (the learning context), or by including a range of different perspectives in terms of content, sophistication and depth of information (promotion of familiarity and diversity around the learning issue). Based on the above epistemological approach for the design and use of an EfS website at the community level, the nine key EfS-related dimensions and pedagogical approaches underpinning the theoretical model (see Table 3.2) are presented in combination with the local characteristics and needs identified during the pre-design phase, and focused around the design process of the EfS website Lanalhue Sustentable.

1. Transformative learning

Based on the reported need of a thinking and paradigm shift within the EfS literature, in regard to the adoption of sustainable principles and practices, the notion of transformative learning involves prompting learners to change, transform, and/or shift the actual paradigms of thinking that have led to current sustainability issues and challenges, to new ways of thinking that aim towards ecological sustainability, and adoption of sustainable living principles and practices (see Section 2.2).

In the context of the Lanalhue Lake, this means to make visible how the principal causes of the accelerated eutrophication are related to a way of thinking that is not ecologically sustainable, and principally related to the type of land use within the lake's catchment. As well, it means to make visible, for example, how the non-regulated increase of holiday cottages and tourism services in the proximity of the lake can directly affect the health of the lake, and in turn the tourism industry itself, due to the ecological footprint of such development by the shores of the lake. It is well known to local experts that these factors, among others, contributed to the increase of organic nutrients in the lake's waters, and that such practices are based on a way of thinking as if the natural environment 'did not matter', or 'will not be affected'.

In terms of the design of educational affordances aimed at promoting transformative learning, making unsustainable practices visible, showing their effects on the local environment, and the type of possible and achievable efforts needed to overcome their negative impact may be an effective way to challenge learners' beliefs, and prompt a thinking shift towards ecological sustainability (Ballantyne & Packer, 2005). This approach can be implemented in the design of EfS affordances such as an educational video, or included within a plain-text section.

2. Systems thinking

Systems thinking is regarded in the literature as a way of thinking that facilitates the understanding of ecological principles that rule all ecological systems (Capra, 1994). It is said that developing systems thinking is essential for the understanding of the nature of sustainability issues and challenges (Sterling, 2001; Strachan, 2009). Systems thinking, in the context of the Lanalhue Lake, involves prompting learners to be able to recognize and identify the existing root causes, interconnections and relationships between all the factors that directly or indirectly contribute to the eutrophication of the lake, or to other ecological, social, environmental, or economic issues in the Lanalhue Lake context.

Such systems thinking could be promoted through multimedia affordances, where the use of diagrams, videos and/or other type of multimedia could assist in making evident such links between the different factors and components involved in the socio-ecological sustainability of the Lanalhue system. One advantage of multimedia affordances is that they can show learners ecological processes that in nature occur at a different temporal scale than in an animation, for example (Caladine, 2008; Mayer & Moreno, 2002).

3. Ecological literacy

Ecological literacy is the notion of understanding the underlying ecological principles of living communities, i.e. ecosystems, and how to live accordingly as a means to 'operate' towards a strong ecological sustainability. In the context of the Lanalhue Lake, understanding the ecological principles that regulate the lake's ecosystem is critical in order to promote ecological understanding and sustainable practices. Special attention must be given to water cycles and flows, making visible to community members and the EfS website's users how the process of eutrophication is linked to this ecological cycle. As well, it is important to show community members and users how the surrounding ecosystem regulates the water quality of the lake, and how perturbations to this ecological balance affect directly the eutrophication process. It is important to acknowledge how systems thinking can facilitate the understanding process of these ecological principles underlying ecological literacy.

Again, such representation of water cycles and flows in the context of the Lanalhue Lake can be achieved through multimedia affordances such as animations, videos and/or diagrams. Or it could also be achieved simply through text-related affordances. The important aspect for the design of the EfS website is that the six fundamental principles of ecosystems as described by Capra (2005b) in Section 2.2.3 need to be infused within the educational message of the EfS website, in particular, regarding the local ecological system being addressed.

4. Future / Long-term thinking

This dimension relates to the notion of meeting our own needs without compromising the needs of future generations. Basically, promoting long-term thinking calls for the consideration of the consequences that today's acts will have in the future.

In the case of the Lanalhue system, this issue is critical as many proposed solutions to address the proliferation of luchecillo lack such considerations. As an example, both local councils have recently acquired aquatic harvesting machines from Canada, and are using them without a scientifically-based management plan. The underlying issue is that many experts have raised the point that if the luchecillo is not harvested following a carefully designed management plan, based on scientific data and monitoring, there is a risk of facilitating the introduction of Cyanobacteria that would most probably ruin the lake's environment for agricultural, social and recreational purposes (Mazzeo, 2005). Similarly, there is a risk of harvesting so much luchecillo that the black-necked swans would no longer have available food, with ecological and ecotourism consequences. These issues could be avoided or minimized by adopting a long-term perspective regarding today's acts and consequences in relation to the management and control of the luchecillo on the part of both local councils.

In terms of the EfS website *Lanalhue Sustentable*, by making evident such lack of long-term thinking and its associated possible negative effects on the local context, through any type of website affordances, or implementing this thinking at different levels within the different website's affordances (e.g. the long-term approach implemented throughout the website's main educational message), may contribute to the development of a long-term thinking ability in learners. From the theoretical model, it seems that by making visible possible negative consequences, whether through a knowledge integration approach, and/or by arousing emotional responses to such negative consequences, may assist the adoption of

long-term thinking in the context of the local sustainability (see Section 3.2.1).

5. Ethics and values

The concept of sustainability involves the idea of adopting ethical principles and values that are in accordance with ecological sustainability. In this sense, from a systems thinking perspective, there are usually many solutions to one problem, but not all of them include ethical principles and values. This can be applied to the forestry industry in the context of the Lanalhue Lake, where the intensive exploitation of natural resources is often carried out without consideration of the local ecological balance, and even sometimes without consideration of the wellbeing of local communities (Comisión Lago Lanalhue, 2007; Dècle & Maignan, 2006; Pauchard et al., 2006). Such lack of ethical principles and values affects directly the quality of the waters of the Lanalhue Lake, which in turn affects the quality of the whole natural environment, and the quality of life of local community members and visitors.

The ethical dimension of sustainability can be incorporated within the narrative and implicit message of the EfS website. For example, and similar to the promotion of long-term thinking, this could be achieved by making visible the effects and consequences of a lack of ethical values and principles on the local socio-ecological sustainability of the target community. In addition, it is also important to educate and show learners the type of ethical principles and values that would be relevant for the local context, in terms of the socio-ecological sustainability at Lanalhue Lake. Such an approach may assist the learning process related to the adoption of ethical principles and values by learners at the local level.

6. Critical thinking:

Critical thinking is the ability to understand, consider and estimate the best action to pursue in a particular situation (Huckle, 1993). As shown in Table 3.3 of the theoretical model in Chapter 3, critical thinking is an important pedagogical component to consider throughout the learning process. In

the early stages, where learners engage with information evaluation and awareness over sustainability issues, critical thinking can assist the building of an ecological understanding over such issues by engaging learners to evaluate arguments, root causes, and related issues of sustainability challenges. In the late stages of the learning process associated with EfS websites, critical thinking is at the basis of political literacy and action competence, as critical thinking skills and abilities can assist learners to address and act upon sustainability issues, take responsible decisions, and achieve the realization of sustainable living (Hofreiter et al., 2007; Huckle & Sterling, 1996; Nicolaou et al., 2009; Tilbury, 1995),

In the context of Lanalhue Lake, it becomes important to promote critical thinking, for example, in relation to the identified existing conceptions regarding local sustainability issues (i.e. data from survey 2b 'Existing sustainability conceptions'). A range of local theories and myths present amongst community members were identified regarding the *what*, *why*, *how* and *when* of issues related to the luchecillo. Some of these theories are clearly alternative conceptions held by local members, whereas others are conceptions generally accepted by authorities that can be reinforced through critical thinking abilities. Data from survey 2b 'Existing sustainability conceptions' indicates that the two most common alternative conceptions regarding the luchecillo is that it is an alga, and that it was brought to the lake by black-necked swans. The luchecillo is an aquatic plant, not an alga, and it was already present in the lake when swans arrived en masse during the year 2004 (CREA, 2010; Lanalhue Sustentable, 2011).

One way to promote critical thinking through the EfS website *Lanalhue Sustentable* can be by engaging learners in knowledge integration regarding different aspects of the eutrophication process of the lake, and by clearly showing how these aspects relate to each other in different ways. Such educational affordance aimed at promoting critical thinking could be achieved in a 'questions and answers' section, where every

question can relate to each other and to a main topic addressed through such questions, e.g. the different aspects related to the luchecillo. These educational affordances included as part of the EfS website can promote the development of critical thinking in learners, by enhancing their ability to analyze and evaluate arguments regarding the local socio-ecological sustainability.

7. Political literacy:

Political literacy empowers community members to understand social rules, and participate within expected norms of behaviour, which are determined by social and political consensus in different types of culture (Tilbury, 1995). In the particular case of the Lanalhue system, political literacy can be related to the understanding of the Chilean environmental law that regulates the issues that are directly or indirectly related to the eutrophication process of the lake (i.e. both at the local and national level). For example, many holiday cottages are not connected to a sewage network, and thus are required by law to comply with certain standards regarding the management of black waters. In addition, political literacy also involves an understanding and knowledge of political, democratic and civic competencies that determine decision-making processes and social participation at the community and social levels. Therefore, political literacy is an important pedagogical component of the EfS website *Lanalhue Sustentable*, as it can guide the type of actions that are congruent with the social norms, structure and rules that are part of the social system at Lanalhue Lake.

In the EfS website *Lanalhue Sustentable* political literacy can be promoted, for example, through a section of the website including and highlighting guidelines that empower local members to address sustainability issues at the societal and political level. For example, the necessary steps to gain council approval for sewage water systems of cottages around the lake; or knowledge about the relevant local government agencies that can be approached to demand measures regarding the sustainability issues at the lake.

8. Understanding of sustainability issues

As mentioned throughout this thesis, the promotion of understanding of sustainability issues is one of the key objectives of EfS websites (the other being the promotion of action). Understanding of sustainability issues is approached here in relation to the ecological understanding of sustainability issues, involving a strong basis on ecological literacy, critical thinking and systems thinking. In the context of the Lanalhue Lake, understanding of sustainability issues means to promote in learners the capacity to comprehend the underlying factors and issues related to the root causes of the accelerated eutrophication process of the lake, and how these are linked to the wellbeing of the community.

Through survey 2b 'Existing sustainability conceptions', as well as in other instances of the pre-design research phase (interviews with key strategic local people), it was possible to assess the relative level of knowledge and understanding of the local community regarding sustainability issues present at Lanalhue Lake. Data indicates that, regardless of high levels of awareness, the level of knowledge and understanding within the local community seems to be low in general. This informed the design team to focus on educational affordances that in general point to basic concepts regarding local issues. Nonetheless, in consideration that communities involve a broad audience where many of its members may have an advanced knowledge and understanding of sustainability issues, it is also necessary to include in the EfS website *Lanalhue Sustentable* more advanced and sophisticated types of information for knowledgeable community members, in order to make it relevant and meaningful to the different types of learners present in the target community.

In general terms, and based on the theoretical model for developing EfS websites, the promotion of learning through the EfS website *Lanalhue Sustentable* can be achieved at different levels, and through a range of pedagogical and learning strategies and website affordances considered for this EfS website. From a systems thinking perspective, the sum of every individual component and theoretical consideration underpinning the

EfS website Lanalhue Sustentable can contribute to the emergence of ecological understanding for local learners.

9. Action competence (AC)

Finally, the last pedagogical component and learning approach for the design and development of EfS websites from Table 3.2 of the theoretical model relates to the promotion of action competence (AC) among local community members. As mentioned in Section 2.2.4, within the EfS literature the action component is regarded as what can lead towards a real improvement of sustainability issues, and thus is crucial for achieving a strong ecological sustainability (Bolstad, 2003b). In this view, the action competence concept highlights that any action undertaken towards ecological sustainability must be done consciously, and thus, needs to be considered and targeted (Jensen & Schnack, 1997), for which critical thinking skills, and a sound ecological understanding, are required. This implies that individuals must comprehend why and for what purpose they are undertaking a particular action, and the possible consequences of such action. Based on this, it is important to promote AC skills through the EfS website *Lanalhue Sustentable*.

In survey 2c 'Website preferences', many participants responded that they would like the proposed EfS website to include information on a set of action guidelines regarding 'what to do' or 'where to go' in particular cases regarding the sustainability of the Lanalhue Lake. Such guidelines represent action competence principles and practices that can be included on the website and assist local learners by making visible the type of possible actions that can be carried out to minimize the effects and consequences of the accelerated eutrophication of the lake. The final objective of enhancing understanding and action for local community members is to empower them to address by their own means the socio-ecological sustainability issues affecting their local environment, and achieve the adoption of sustainable living principles and practices within the target community.

Overall, and according to the theoretical model, the nine key EfS-related pedagogical components from the model to consider for the development of an EfS website in the context of Lanalhue Lake can be implemented and addressed through the EfS website‘s features and affordances. This is in consideration of the local characteristics and needs of the target community, as well as the local context of ICT use, both identified and determined during the pre-design research phase.

Moreover, in regard to other design considerations not mentioned in this section yet, it is critical to present the *big picture* of the accelerated eutrophication process occurring at Lanalhue Lake. This is in order to provide learners different aspects, angles and perspectives of the sustainability issues, and facilitate the integration of knowledge and ecological understanding for learners (Schweitzer et al., 2008). In addition, some literature indicates the presence of a possible failure on the part of environmental educators to explain and demonstrate the gains of sustainable living, which calls for a more positive way of communicating, not just about doomed futures as sometimes shown by the film industry (Blincoe, 2009). In the context of Lanalhue Lake this can be done by including within the overall message of the EfS website that a sustainable Lanalhue Lake is possible and achievable, which according to experts it is. Finally, as highlighted in the literature, arousing emotional responses in learners in free-choice learning contexts, such as an EfS website, can also enhance and facilitate the learning process that may occur through the EfS website.

In summary, the EfS website *Lanalhue Sustentable* should address the nine key pedagogical components from the theoretical model, as well as other considerations as mentioned above, in combination and consideration of the local socio-ecological and technological characteristics and needs, which were assessed during the pre-design research phase. In this section the theory from the model and the data collected from the target community were presented and discussed in the form of a framework to inform and guide the design process of the EfS

website Lanalhue Sustentable. Special attention was given at the start of the section with regard to epistemological views related to systems thinking and activity theory adopted for the development of such an EfS website. The final objective of EfS websites addressed at the non-formal and community education level is to promote understanding and action towards ecological sustainability, based on locally rooted sustainability issues and challenges. The next section presents the EfS website Lanalhue Sustentable that was designed in this study.

5.4.2 The EfS website Lanalhue Sustentable

Based on the framework for the development of an EfS website in the context of the Lanalhue Lake in Chile presented in the previous section, this section presents the EfS website *Lanalhue Sustentable*. The design phase of this EfS website was carried out between September 2010 and February 2011. The core design team was composed of one website designer and developer, one graphical designer, and the researcher as the EfS educator. In addition, three local community members collaborated by providing feedback throughout the design and development of the EfS website, within a user-informed design format. Many other local and non-local collaborators by invitation from the design team provided materials to be included as part of the contents of the EfS website, such as short articles, videos, photos, and/or documents.

The first step of the design phase was to determine the general layout of the website. This was achieved through brainstorming sessions and modelling of the educational system related to the sustainability of the Lanalhue Lake. Such brainstorming was based on theory from the model and data from the pre-design research phase, and in consideration of the local activity system determined by the use of the EfS website within the local socio-ecological context (see Figure 5.4). Five overarching EfS components underlying the Lanalhue Lake system and EfS website were identified during the brainstorming sessions, in relation to sustainability issues affecting the lake and local community members. These five main

components were taken as the five educational areas of the EfS website, and guided the structural layout of the website. These were:

- Sustainability, local sustainability, and education for sustainability (EfS)
- Lanalhue Lake general characteristics and related information
- Mapuche knowledge and worldview (local indigenous knowledge)
- Sustainability 1: Eutrophication related sustainability issues
- Sustainability 2: Non-eutrophication related sustainability issues

The aim of the design team was to cover all the areas that seemed important to address through the EfS website within the local context. In first place, by being an educational website addressing the concept of sustainability, one educational area of the website had to address this concept in general terms, and apply it to the local context.

On the other hand, as this EfS website was addressing socio-ecological sustainability issues at Lanalhue Lake in Chile, it seemed logical to the design team to include this as another educational area of the website addressing the general characteristics of the lake. Regarding the inclusion of indigenous knowledge as a third educational area, this came from consideration of systems thinking, ICT and community education that highlight the importance of addressing the local socio-cultural context. It was mentioned earlier in this chapter that this area of Chile is recognised historically as a Mapuche area. In addition, some data from the pre-design research phase also indicated this aspect as relevant and meaningful to some participants. Finally, the two last educational areas of the website aimed to address all the socio-ecological sustainability issues present in the area, but organised in such a way that the eutrophication of the lake appears on the website as its principal focus.

The second step of the design process was to break down this guiding layout composed of five main educational areas, into the final structural organisation and layout of the EfS website. This was carried out through brainstorming and discussion sessions of the design team, in

consideration of the theory from the model, and data collected during the pre-design research phase. The final organisation of the EfS website was defined in terms of heading elements of the website (menu bar at the top of the website); the main body of the website; and the footnote of the website. Table 5.4 presents the final structural organisation of the home page of the EfS website Lanalhue Sustentable.

Table 5.4. Structural organisation of the EfS website *Lanalhue Sustentable*.

Heading elements / Menu bar of the website
1a. Lanalhue Lake
1b. Sustainability
1c. Luchecillo
1d. Solutions
1e. Questions and answers (frequently asked questions)
1f. Documentation
Main body elements of the website
2a. Multimedia
2b. Questions and answers (repeated)
2c. Participation box, inviting users to get involved with the project
2d. Subscription to the Lanalhue Sustentable Newsletter
3a. Articles from collaborators
3b. Experiences and examples of local and non-local sustainability initiatives
3c. Mapuche knowledge and worldview
Footnote elements of the website
4a. Credits
4b. Links to social media websites, and to other websites of interest
4c. Waikato university logo and link

As can be seen in Table 5.4, the menu of the website contains elements related to the sustainability of the lake around the concept of the luchecillo,

and including related sections, such as a solutions section, a frequently asked questions section, and a documentation section. This menu bar is what the design team defined as the primary elements of the EfS website, focused around the eutrophication issue. The body of the website contains a mix of primary and secondary elements addressing issues related to the eutrophication of the lake, non-eutrophication issues, and Mapuche knowledge and worldview aspects. Finally, the bottom of the EfS website, or footnote area, included elements considered tertiary elements of the website, such as the credits and links to social networking websites and to other websites of interests.

Once the structural organisation of the website was defined, the design and development of the content and affordances of the website could start. This included populating every section and subsection of the website with content and affordances based on the framework presented in Section 5.4.1. This process included the implementation of the theoretical, pedagogical and ICT-related aspects discussed in the framework for developing the EfS website. The framework served as a guide to carry out this process, which included the participation of more than twenty collaborators in the website who provided a range of materials, and helped with the development of the affordances of the website, e.g. photo editing. In terms of the five systems thinking and complexity theory in education considerations for the creation and nurture of educational systems presented in the first part of Section 5.4.1, the achievement of a decentralised control structure, and enabling expressions of diversity were intended to be addressed by having a large number of collaborators providing input to the EfS website.

Regarding the systems thinking considerations related to promoting the interaction between learners with the website and amongst themselves, which is said contributes to the nurturing of educational systems (Davis & Sumara, 2005), these were intended to be addressed through Web 2.0 and social networking affordances (e.g. Facebook and Twitter accounts lined to the EfS website). The last theoretical consideration for the creation

and nurture of educational systems related to providing familiarity of the learning issue was addressed throughout the design process by identifying and addressing locally relevant and meaningful issues in the context of the Lanalhue Lake.

Besides recommendations for the creation and nurture of educational systems, described in Table 3.1 from the theoretical model presented in Chapter 3, other systems thinking approaches for community-based educational settings are the promotion of coupling and interaction of learning actors (the EfS website and community members considered as learning actors). This was addressed through the design of a website based on locally relevant issues, which in theory should make the website meaningful to local people, and thus motivating for them to engage with the EfS website through an interactive process; and by including Web 2.0 and social networking affordances, in case such interaction were to occur between two or more community members through a social networking website.

Finally, the other two systems thinking approaches from Table 3.1 relate to addressing the local learning context to provide meaningful experiences to learners, which has been addressed through data collected during the pre-design research phase; and to regard the EfS website and associated educational system as an educational facilitator. In this regard, the EfS website was developed considering this principle as a driving concept during the whole design phase. Figure 5.5 presents the EfS website *Lanalhue Sustentable* (visit URL http:// lanalhuesustentable.cl) with an indication of the implementation of some other theoretical considerations.

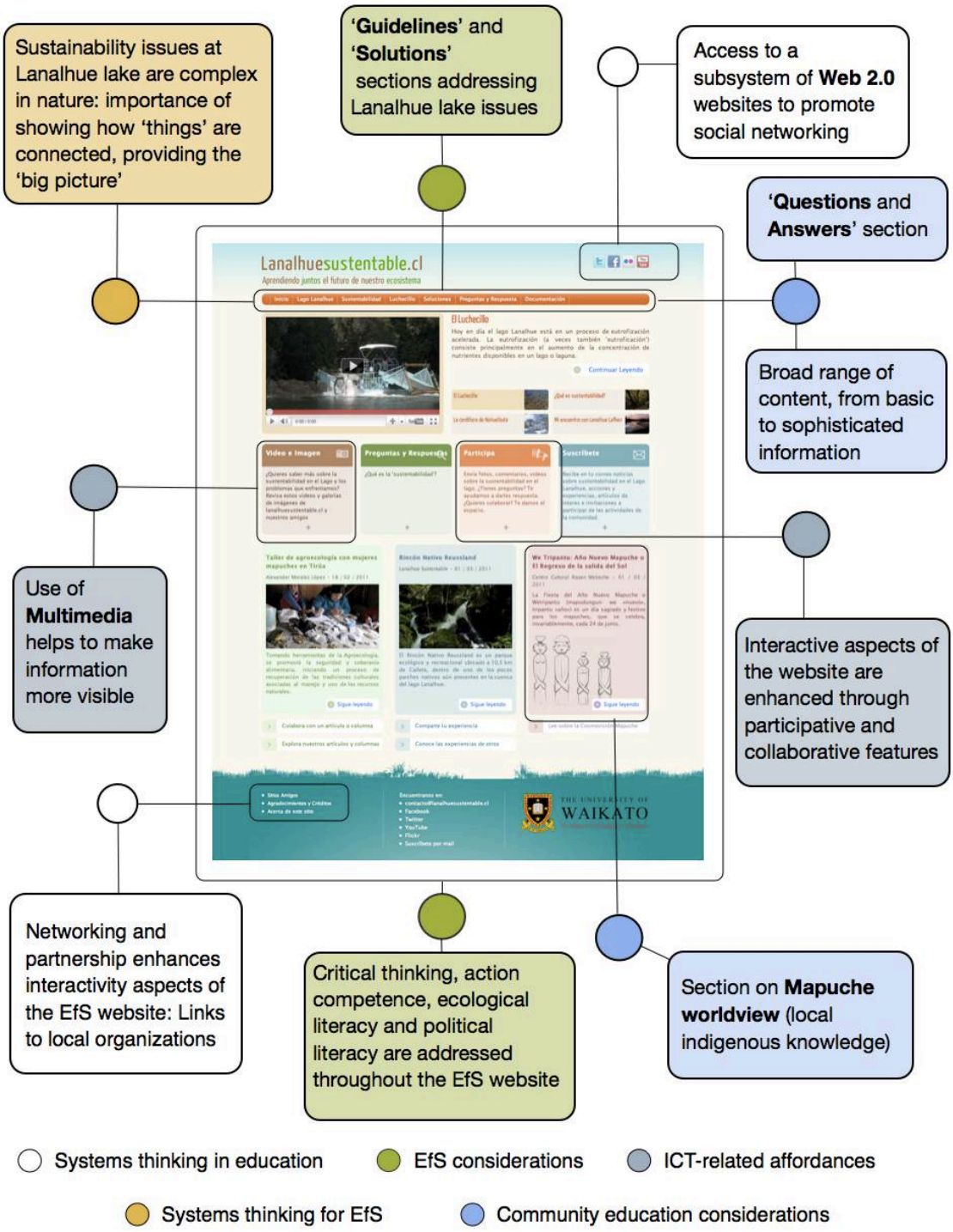

Figure 5.5. Organisational layout of the EfS website *Lanalhue Sustentable*.

5.4.3 Summary

In the first part of this section a framework based on theoretical considerations from the model for developing EfS websites from Chapter 3, and informed by data collected during the pre-design research phase was presented. This framework focused first on epistemological issues

related to the adoption of systems thinking and complexity theory in educational settings, as well as presenting activity theory-related aspects of the Lanalhue Lake educational activity system. In essence, the framework provided guidelines to the design team for the design and development of the EfS website Lanalhue Sustentable.

This was followed by accounts of decisions that the design team had to consider, as well as some design stages encountered during the development of the EfS website. As mentioned earlier in this section, this design phase of the website involved a period of approximately six months, which cannot be accounted for here in detail. Nevertheless, some important aspects of the design process have been highlighted, and the EfS website *Lanalhue Sustentable* is shown in Figure 5.5, including some indications of the implementation of theoretical considerations from the model presented in Chapter 3 within the home page of the website.

5.5 Summary

This chapter presented the intervention phase of the study which included an introduction to the socio-ecological characteristics and needs of the target community; an overview of the research phases preceding the design of the EfS website Lanalhue Sustentable; and an overview of the design phase of the EfS website, where considerations from the theoretical model for developing EfS websites presented in Chapter 3 were combined with data collected during the pre-design research phase. In regard to the socio-ecological characteristics and needs of the target community, the principal sustainability issue affecting the target community was seen to be the accelerated eutrophication process of the Lanalhue Lake, which not only is affecting the natural balance of the local ecosystem, but also affects the local community and visitors to the lake. Other socio-ecological sustainability issues present in the target community were also identified and considered within the design of the EfS websites.

During the pre-design research phase of the intervention, further information was retrieved through different data collection methods and phases aimed at achieving a deeper understanding of the local, social, cultural, and ecological characteristics and needs of the target community. In addition, survey 2b 'Existing sustainability conceptions' permitted the design team of the EfS website to assess the type of conceptions existing within the local community, with the aim of addressing and challenging identified alternative conceptions, and to reinforce sustainability conceptions that were found to be held, in terms of the socio-ecological sustainability issues affecting the Lanalhue Lake. Survey 2c 'Website preferences' allowed the design team to obtain valuable information regarding the existing type of ICT use within the target community, as well as the Internet website preferences of community members that participated of this survey.

The design phase was characterised by the design and development of the EfS website *Lanalhue Sustentable*, aimed at being used as the intervention of this study investigating the affordances of ICT for community EfS. The first part of the design phase involved the development of a framework informing the design of the website, which combined data collected during the pre-design research phase with theoretical considerations from the model for developing EfS websites from Chapter 3. This combination of theory, data, and other relevant information guided the design team during the development of the EfS website *Lanalhue Sustentable*, presented in the final part of this chapter.

Once ready, the website *Lanalhue Sustentable* was used as the research instrument for the investigation of the use of EfS websites for community education in the context of the target community associated to the Lanalhue Lake in Chile. In Chapters 6 to 8, the findings related to the use of the EfS website *Lanalhue Sustentable* by local community members, and its potential for the promotion of understanding of local sustainability issues and action towards local socio-ecological sustainability are presented.

CHAPTER 6 - USE OF THE EFS WEBSITE *LANALHUE SUSTENTABLE* BY COMMUNITY MEMBERS

6.1 Introduction

The intervention in this study consisted of four data collection phases: (I) the pre-intervention phase (i.e. phase 4a), based on a questionnaire survey; (II) the intervention phase, or use of the EfS website by participants (i.e. phase 4b); (III) the post-intervention phase, consisting of an interview right after the use of the EfS website by participants (i.e. phase 4c); and (IV) the follow-up phase (i.e. phase 4d), which included an online survey 5 months after the first intervention. This data collection design aimed to assess the two key concepts of the present study: if EfS websites can improve *understanding* about sustainability issues at the community level; and if EfS websites can promote *action* towards socio-ecological sustainability.

However, before being able to evaluate those key concepts in regard to the use of an EfS website by community members, it is necessary to evaluate and understand first *how* do community members use an EfS website, and *what for*. These are the key points addressed in this chapter, for which a series of survey questions from the pre-intervention questionnaire, the post-intervention interview, and the follow-up survey were designed, and from which a series of findings will provide, at the end of the chapter, a picture of the use of the EfS website lanalhuesustentable.cl by local community members from the Lanalhue Lake area in Chile.

The first part of this chapter (i.e. Section 6.2) focuses on characterizing participants' demographics and pre-intervention profiles regarding ICT expertise and knowledge on the use of the Internet, and regarding their knowledge about Lanalhue Lake sustainability issues, prior to their first use of the EfS website. The second part of this chapter, based on data from Google Analytics and on interviews carried out right after participants' first use of the EfS website, aims to assess quantitative aspects of

participants' use of the EfS website, and qualitative aspects related to participants' perceptions of the EfS website.

Finally, the third part of the chapter addresses participants' re-visits to the EfS websites during the follow-up period, with description of quantitative aspects of re-visits reported by participants, and attention to the purpose of these re-visits and participants' final perceptions towards the EfS website. Findings from this chapter will develop an overall understanding of how community members used the EfS website lanalhuesustentable.cl, and what for. Names used are pseudonyms for the participants.

6.2 Participants' pre-intervention profiles and knowledge

This section focuses on findings from the pre-intervention questionnaire (i.e. phase 4a), carried out during March 2011 with 24 local community members from the Lanalhue Lake area who accepted the invitation to participate in this study. The aim of the pre-intervention questionnaire was to retrieve information on participants' demographic characteristics, environmental-interest profiles related to Lanalhue Lake, knowledge regarding sustainability issues present at Lanalhue Lake, and possible actions to help the environment of Lanalhue Lake that participants may have taken prior to the intervention. As well, the pre-intervention questionnaire also aimed to assess participants' Internet access and ICT expertise and knowledge. The duration of the pre-intervention questionnaire was between 8 to 15 minutes, and included 13 questions with some associated sub-questions.

In the first subsection (i.e. Section 6.2.1), data from participants' demographic characteristics and their profiles regarding self–reported knowledge and interest towards Lanalhue Lake are presented. The second subsection, i.e. Section 6.2.2, deals with ICT aspects, presenting first participants' reported Internet expertise and use, and second, participants' use of websites to assess local or non-local environmental and/or sustainability issues, prior to their first use of the EfS website lanalhuesustentable.cl (i.e. phase 4b). Finally, Section 6.2.3 presents a

summary of key findings regarding participants' profiles, ICT literacy, and environmental knowledge related to Lanalhue Lake.

6.2.1 Participants' profiles and demographic characteristics

Participants' demographic characteristics and profiles regarding self-reported environmental interest and knowledge about Lanalhue Lake issues were assessed by means of the following close-ended questions from the pre-intervention questionnaire:

- Q1. Which of these age brackets are you in?
- Q2. Please indicate your gender.
- Q3. Which area do you live in?
- Q4. How long have you lived there?
- Q9. How often have you visited Lanalhue Lake?
- Q10. Please rate your *interest* in environmental/sustainability issues at Lanalhue Lake.
- Q11. Please rate your *knowledge* regarding environmental / sustainability issues at Lanalhue Lake.

The first four questions are demographic questions, helping to define the survey's sample with respect to the target community, and to carry out analysis of sub-groups of participants if required. Whereas, the last 3 questions principally intended to characterise participants' self-reported general interest and knowledge regarding environmental and/or sustainability issues present at Lanalhue Lake, in order to determine their self-reported pre-intervention knowledge regarding such issues.

6.2.1.1 Participants' demographic characteristics

All 24 participants provided answers to questions Q1 to Q4 of the pre-intervention questionnaire. Answers to question Q1 (i.e. participants' age bracket) indicate that:

- 16/24 participants were between 40 and 59 years old at the time of the intervention;
- 6/24 participants were between 20 and 39 years old;
- One participant was between 0 and 19 years old (i.e. Pamela);

- And one participant reported being over 60 years old (i.e. Manuel).

Concerning question Q2 dealing with participants' gender, 12/24 participants were female, and the other half were male participants. In regard to the area where participants live (i.e. question Q3), answers report that:

- 14/24 participants live within the Cañete area;
- 7/24 participants live in the Contulmo area;
- 2/24 participants reported to live in Peleco;
- And one participant, i.e. Rafael, reported to live on the shores of Lanalhue Lake (i.e. near the Contulmo area).

Note that geographically Cañete is the farthest city to Lanalhue Lake (i.e. approximately 18 kilometres north), also being the most populated city around the lake (i.e. approximately 22,000 inhabitants); then come Contulmo (i.e. with approximately 5,000 inhabitants, however during holiday season this can reach over 7,000) and Peleco (i.e. around 500 inhabitants), both practically within one kilometre away of the lake but in opposite locations (i.e. Contulmo is located in the south-east end of the lake, whereas Peleco is in the north-west side of the lake; see Figure 5.1).

Answers to Q4 regarding the time over which participants have been living in the place they reported indicate that:

- 18/24 participants have been living there for more than 5 years (i.e. considered here as *historically* local community members);
- 3/24 participants have been living in the area between 1 and 5 years (i.e. Julia, Mauricio and Emilio);
- And the remaining 3/24 participants (i.e. Mateo, Javier and Rafael) have been living in the area for less than one year, hence considered as *new* members of the local community. Table 6.1 below summarizes this demographic data, plus data regarding participants' occupation and/or work sector identified during post-intervention interviews.

Table 6.1. Participants' demographic characteristics (n = 24).

Participant ID	Q1. Age bracket	Q2. Gender (F / M)	Q3. Living area	Q4. Living time (years)	Participants' occupation / work sector
Doris	40 - 59	F	Cañete	5 +	Local Council
Mario	20 - 39	M	Cañete	5 +	Local Council
Maria	40 - 59	F	Cañete	5 +	NGO
Romina	40 - 59	F	Cañete	5 +	School
Pamela	0 - 19	F	Cañete	5 +	Tertiary student
Oscar	40 - 59	M	Cañete	5 +	Government Agency
Marisol	20 - 39	F	Cañete	5 +	NGO
Benjamin	40 - 59	M	Cañete	5 +	Private sector
Javiera	40 - 59	F	Cañete	5 +	Government Agency
Pablo	40 - 59	M	Cañete	5 +	School
Nora	40 - 59	F	Cañete	5 +	Private sector
Ramiro	40 - 59	M	Contulmo	5 +	School
Mariana	40 - 59	F	Contulmo	5 +	School
Soledad	40 - 59	F	Contulmo	5 +	School
Rosario	40 - 59	F	Contulmo	5 +	School
Ernesto	40 - 59	M	Contulmo	5 +	School
Manuel	60 +	M	Contulmo	5 +	School
Ana	40 - 59	F	Peleco	5 +	Private sector
Julia	40 - 59	F	Cañete	1 - 5	Local Council

Participant ID	Q1. Age bracket	Q2. Gender (F / M)	Q3. Living area	Q4. Living time (years)	Participants' occupation / work sector
Marcelo	20 - 39	M	Cañete	1 - 5	Government Agency
Emilio	40 - 59	M	Peleco	1 - 5	Tertiary Institution
Mateo	20 - 39	M	Cañete	0 - 1	School
Javier	20 - 39	M	Contulmo	0 - 1	School
Rafael	20 - 39	M	Lanalhue Lake	0 - 1	School

6.2.1.2 Participants' interest and knowledge of Lanalhue Lake issues

Concerning participants' answers to questions Q9 to Q11, for question Q9, i.e. 'how often have you visited Lanalhue Lake?', answers were:

- 11/24 participants reported that they have visited the lake more than 10 times (i.e. this being the maximum possible category from the questionnaire);
- 3/24 participants answered that they have visited the lake between 6 to 10 times (i.e. Benjamin, Marcelo and Rosario);
- 2/24 participants reported having visited the lake between 2 to 5 times (i.e. Marisol and Mateo);
- And only one participant, i.e. Nora, indicated that she has visited the lake only once.
- The remaining 7/24 participants answered 'I live there' to question Q9, meaning that whether they live in Contulmo, Peleco or just by the shores of the lake like Rafael, or that they live in Cañete but have relatives or a holiday cottage at the lake.

Regarding answers to question Q10 dealing with participants' *interest* in environmental and/or sustainability issues at Lanalhue Lake:

- 16/24 participants reported to have a high interest;
- 6/24 participants indicated a moderate interest;
- And Nora and Rosario said that their interest towards environmental and/or sustainability issues at Lanalhue Lake was low.

For question Q11 dealing with *knowledge* about environmental and/or sustainability issues at Lanalhue Lake, only Romina reported that she felt she had a *very good* knowledge regarding such issues, 7/24 participants answered that they had a *good* knowledge about those issues, and the remaining 16/24 participants indicated they had a *poor* knowledge regarding environmental and/or sustainability issues present at Lanalhue Lake. Table 6.2 summarizes answers to questions Q9 to Q11 dealing with participants' interest and knowledge of Lanalhue Lake issues.

Table 6.2. Participants interest and knowledge about Lanalhue Lake (LL) (n = 24).

Participant ID	**Q9. Number of visits to LL (times)**	**Q10. Interest towards LL**	**Q11. Knowledge about LL**
Doris	10 +	High	Good
Mario	10 +	High	Good
Pamela	10 +	High	Good
Ramiro	10 +	High	Good
Ernesto	I live there	High	Good
Rafael	I live there	High	Good
Julia	10 +	High	Poor
Oscar	10 +	High	Poor
Soledad	10 +	High	Poor
Marisol	2 - 5	High	Poor

Participant ID	Q9. Number of visits to LL (times)	Q10. Interest towards LL	Q11. Knowledge about LL
Mateo	2 - 5	High	Poor
Benjamin	6 - 10	High	Poor
Ana	I live there	High	Poor
Emilio	I live there	High	Poor
Javiera	I live there	High	Poor
Romina	10 +	High	Very good
Nora	1	Low	Poor
Rosario	6 - 10	Low	Poor
Manuel	I live there	Moderate	Good
Javier	10 +	Moderate	Poor
Mariana	10 +	Moderate	Poor
Pablo	10 +	Moderate	Poor
Marcelo	6 - 10	Moderate	Poor
Maria	I live there	Moderate	Poor

Overall, the above data indicates that participants as a group present, in general, a fair-to-high interest towards environmental and/or sustainability issues at Lanalhue Lake, with 2/3 of them reporting a poor knowledge of those issues; with the odd exception like Romina who is the only participant reporting a very good knowledge about the lake's issues (i.e. this being the maximum category possible from Q11). In regard to participants as a cohort, it can be said that they are mainly from the area, with 3/4 of them reporting to have lived there for over 5 years, (i.e. the maximum category from Q4), and 3 of them reporting to have been living there for less than a year. Regarding participants' place of residency, the majority (i.e. n = 14) live in Cañete, the most populated town in the Lanalhue Lake area, and the second majority (i.e. n = 7) are from

Contulmo, the second biggest town in the area, and geographically closer to the lake. In terms of participants' gender, the sample is equally balanced.

6.2.2 Participants' Internet literacy and use

The second aspect addressed as part of the participants' pre-intervention profiles and knowledge was participants' ICT expertise and Internet use. To assess this, the pre-intervention questionnaire included the following 4 questions and sub-question about Internet access and knowledge:

- Q5. Please rate the access you have to the Internet.
- Q6. Please rate your expertise/knowledge on the use of the Internet.
- Q7. Please indicate where you usually get connected to the Internet.
- Q8. Do you use websites to get information about environmental/ sustainability issues?

    Q8a. If you do use websites concerned with environmental and sustainability issues, what do you use them for?

Questions Q5 to Q7 dealt with participants' ICT and Internet literacy and use, in particular the level of Internet access they have, their perceived level of expertise, and the place where they usually get connected. Regarding use of websites to get information about environmental and/or sustainability issues, question Q8 and sub-question Q8a intended to assess participants' use of websites for such purposes, prior to their first use of the EfS website *Lanalhue Sustentable.*

6.2.2.1 Participants' Internet literacy and use

Answers to question Q5, dealing with participants' access to the Internet, show that 22/24 participants had access to the Internet whenever they need it, with Javier and Rosario who stated they had access to the Internet only *sometimes*. Regarding question Q6 about expertise and knowledge on the use of the Internet:

- 7/24 participants reported to have *very good* expertise and knowledge on the use of the Internet;
- 16/24 participants answered that they had *good* expertise and knowledge;
- And Rosario stated that she had *poor* expertise and knowledge regarding the use of the Internet.

With regard to the place where participants usually access the Internet, answers to question Q7 show that:

- 10/24 participants access the Internet from their home;
- 8/24 participants do so both from their home and from their workplace;
- 5/24 participants access the Internet exclusively from their workplace;
- And Ana stated that she accesses the Internet from her home and from the community library, in Cañete (Table 6.3 below summarizes data for questions Q5 to Q7).

Table 6.3. Participants' Internet access and expertise/knowledge (n = 24).

Participant ID	**Q5. Internet access**	**Q6. Internet expertise / knowledge**	**Q7. Access place**
Romina	Whenever I need it	Very good	Home
Pamela	Whenever I need it	Very good	Home
Rafael	Whenever I need it	Very good	Home
Javiera	Whenever I need it	Very good	Home, work
Nora	Whenever I need it	Very good	Home, work
Benjamin	Whenever I need it	Very good	Work
Emilio	Whenever I need it	Very good	Work
Julia	Whenever I need it	Good	Home
Maria	Whenever I need it	Good	Home

Participant ID	Q5. Internet access	Q6. Internet expertise / knowledge	Q7. Access place
Javier	Sometimes	Good	Home
Mateo	Whenever I need it	Good	Home
Ernesto	Whenever I need it	Good	Home
Manuel	Whenever I need it	Good	Home
Ana	Whenever I need it	Good	Home, library
Doris	Whenever I need it	Good	Home, work
Marcelo	Whenever I need it	Good	Home, work
Oscar	Whenever I need it	Good	Home, work
Marisol	Whenever I need it	Good	Home, work
Pablo	Whenever I need it	Good	Home, work
Ramiro	Whenever I need it	Good	Home, work
Mario	Whenever I need it	Good	Work
Mariana	Whenever I need it	Good	Work
Soledad	Whenever I need it	Good	Work
Rosario	Sometimes	Poor	Home

Data from questions Q5 to Q7 indicate that the majority of participants (i.e. n = 22/24) have access to the Internet whenever they need it, with 7/24 participants reporting *very good* expertise and knowledge regarding Internet use, and 2/3 of participants reporting *good* expertise and knowledge. Only Javier and Rosario reported that they have access to the Internet only *sometimes*, with Javier reporting good expertise and knowledge, and Rosario rating herself with poor expertise and knowledge, indicating that she was the participant with the least Internet literacy. Rosario also stated that she has a low interest for Lanalhue Lake, and a poor knowledge of environmental and sustainability issues present on the

lake. Regarding the place where participants access the Internet, the majority of them access it from their home and/or workplace, with Ana being the only participant reporting another access place, the community library in Cañete.

6.2.2.2 Participants' use of environmental / sustainability websites

Question Q8 and sub-question Q8a assessed participants' reported use of environmental and/or sustainability websites, prior to their first use of the EfS website lanalhuesustentable.cl. Answers to question Q8, i.e. use of websites to get information about environmental/sustainability issues, indicate that:

- 3/24 participants *always* do so (i.e. Maria, Romina and Ramiro);
- 6/24 participants *often* do so;
- 10/24 responded *sometimes*;
- And 5/24 participants indicated *rarely* as their answer option.

Note that none of the participants answered *never*, this being the fifth possible answer option from question Q8. Table 6.4 presents these answers, indicating participants scoring under each category.

In regard to qualitative data from sub-question Q8a (i.e. If you do use websites concerned with environmental and sustainability issues, what do you use them for?), answers from 22 participants were analyzed using theme code 7.00 of the Codebook, i.e. 'use of other environmental/sustainability websites'. Three recurrent subthemes were identified from participants' answers (i.e. from n = 22), being 'to gain further knowledge' (*theme code* 7.105) the most recurrent with 9/22 participants scoring under it. The second most recurrent subtheme, with 8/22 participants scoring, was 'for general information purposes' (*theme code* 7.10), and finally, with 6/22 participants scoring, was subtheme 'work needs' (i.e. note that 2 answers were coded under two different subthemes). In addition, Rosario answered "No" to question Q8a (Rosario, pre-intervention questionnaire, *seq.* 21), suggesting that she does not use websites to access environmental and/or sustainability issues (*theme code*

7.20). Previously in question Q8, Rosario reported that she *rarely* visits environmental and/or sustainability related websites.

Table 6.4. Participants' use of environmental and/or sustainability websites (n = 24; 'A' = 'answer').

Q8. Do you use websites to get information about environmental/ sustainability issues?			
A: *Always*	A: *Often*	A: *Sometimes*	A: *Rarely*
Maria	Doris	Julia	Pablo
Romina	Mario	Ana	Mariana
Ramiro	Pamela	Marisol	Marcelo
	Oscar	Benjamin	Nora
	Emilio	Javiera	Rosario
	Javier	Soledad	
		Rafael	
		Mateo	
		Ernesto	
		Manuel	

Concerning answers from the most recurrent subtheme, i.e. visiting environmental and/or sustainability websites 'to gain further knowledge', Mario reported to visit such websites "as a reference to learn, inform myself and to be able to analyze different subjects that I like to research on" (Mario, pre-intervention questionnaire, *seq.* 3), and Pamela reported "to look for information about specific subjects, from research projects, or to answer any doubt I may have, or just curiosity to learn more about such issues" (Pamela, pre-intervention questionnaire, *seq.* 8). Another answer coded under this same subtheme is the one from Manuel, who reported that he looks for environmental and/or sustainability information to learn more about local ecological issues and apply such information in taking action:

> [I visit such websites] to increase my knowledge regarding environmental issues and be able to discuss and defend with argument the conservation of local wetlands, and also to be able to actively take action towards their defence and conservation.
>
> (Manuel, pre-intervention questionnaire, *seq.* 25)

Regarding examples of answers from the second most recurrent subtheme, i.e. 'for general information purposes', Ramiro stated that he visits such websites "to access documents, to satisfy my personal needs, and to keep myself informed" (Ramiro, pre-intervention questionnaire, *seq.* 17). Other examples coded under this category come from Javiera, who said "I use such websites just for general knowledge purposes" (Javiera, pre-intervention questionnaire, *seq.* 13), and from Marisol, who simply reported that she visited such websites "to be informed about particular issues" (Marisol, pre-intervention questionnaire, *seq.* 11).

Finally, an example of answers for the least recurrent subtheme, where participants reported that they visited environmental and/or sustainability websites for 'work needs' (i.e. *theme code* 7.05), is the one from Ana, who reported that she visits such websites "to get to know more, and to apply the information to improve the productivity of my business" (Ana, pre-intervention questionnaire, *seq.* 9). Another example coded under subtheme 'work needs' is the one from Javier: "to obtain information on any particular subject and use it to prepare my classes" (Javier, pre-intervention questionnaire, *seq.* 18).

As a summary of this subsection dealing with participants' use of other environmental and/or sustainability-related websites, it can be said that all participants (i.e. n = 24) reported having visited these kinds of websites prior to the intervention. However, 9/24 of them have done so more frequently than the rest (i.e. participants answering *always* and *often* to question Q8), as 10/24 participants reported that they have visited such websites *sometimes*, and 5/24 participants declared doing so *rarely*. Concerning the purpose of visiting such websites, or the 'what for', the 3

recurrent subthemes identified were related to information access, whether for general knowledge purposes, to further enhance knowledge about environmental and/or sustainability issues, or to apply such information to work related needs.

6.2.3 Summary

As a summary of this section dealing with participants' profiles and demographic characteristic, it can be said that participants as a cohort reflect members of the target community, with members from the principal populated areas around Lanalhue Lake represented within the cohort. In terms of participants' age, the majority of them were between 40 and 59 years old (i.e. 16/24), and the second majority have between 20 and 39 years old (i.e. 6/24). Regarding time living in the area, the majority of participants (i.e. 18/24) have lived there for more than five years, considered in this study as *historically* local community members, and the remaining 6 participants having lived in the area for less than 5 years, with three of them having lived there even for less than a year.

In regard to participants' pre-intervention reported interest and knowledge towards Lanalhue Lake issues, more than half of participants (i.e. 16/24) reported to have a *high* interest towards the lake's issues, and 6 of them reported a *moderate* interest, with only Nora and Rosario reporting a *low* interest towards the lake's issues. Despite this evident tendency towards a high interest towards Lanalhue Lake's issues, 2/3 of participants reported to have a *poor* knowledge regarding such issues. On the other hand, regarding Internet literacy and use, 22/24 participants reported to have access to the Internet whenever they need it, and 23/24 participants reported to have at least a *good* expertise and knowledge in the use of the Internet (i.e. with 7 of those 23/24 participants reporting a *very good* expertise and knowledge).

These figures support the idea of the Lanalhue Lake's socio-cultural contexts being appropriate to conduct the present research study on EfS through ICT, as amongst the participants there was strong *interest* in

environmental and sustainability issues, but with relatively *poor* knowledge over those issues, and a reasonable ICT-literacy in the cohort of local community members. Finally, all participants reported to have used, at least at some point, websites to access environmental and/or sustainability related information for different purposes.

6.3 Use of the EfS website *Lanalhue Sustentable*

During the intervention phase (i.e. phase 4b), participants were invited to visit the EfS website *Lanalhue Sustentable*. The visit consisted of participants freely browsing the website during a period of time of 10 to 20 minutes, depending on participants' motivation and time availability. The visit to the EfS website was carried out from a desktop or a laptop computer (i.e. participant's usual computer or researcher's laptop), depending on the particular situation; and usually in a quiet and familiar environment to provide a favourable setting to participants.

Immediately after the use of the website, participants were invited to take part in a post-intervention interview (phase 4c), where they were asked a series of questions to evaluate three main points related to their experience of using the EfS website: (1) participants' perceptions and opinions about the EfS website; (2) participants' learning and understanding processes related to the use of the EfS website; and (3) participants' motivation to take action and to adopt sustainable living principles prompted by the EfS website. In this section, the focus is on the first aspect of the post-intervention interview.

In addition to qualitative data collected during the post-intervention interview, additional quantitative data from the use of the EfS website by participants during the intervention period was retrieved using Google Analytics tools. This quantitative data service provided by Google Inc. principally allows a website owner to retrieve data about the visits to a website by its audience, i.e. visitors' demographics, pages visited during a session, or the type of web browser used by visitors. In the case of the present study, the main type of information retrieved were two standard

reports provided by Google Analytics: the Visits Overview (i.e. metrics on visits to the website), and the Content Overview (i.e. metrics on content visited), both corresponding to visits to the EfS website *Lanalhue Sustentable* during the intervention period.

In this section, findings from both qualitative and quantitative sets of data related to the use of the EfS website by participants are presented. First, Section 6.3.1 addresses quantitative data retrieved from Google Analytics, then, Section 6.3.2 presents qualitative findings from the post-intervention interview. Finally, Section 6.3.3 summarises key points and findings from these two sets of data.

6.3.1 Use of the EfS website by participants

Quantitative data on the use of the EfS website *Lanalhue Sustentable* by participants during the intervention period (i.e. from 7th March to 10th March 2011) were retrieved using Google Analytics tools. Data from Google Analytics (GA) includes a general overview of the visits to the EfS website (i.e. Visits Overview report), and a review of the pages and type of content visited (i.e. Content Overview report). Note that because of the way GA works with data from Internet, the minimum unit of time available for analysis from GA was hour-level data for the Visits Overview, and day-level data for the Content Overview. In both cases this means that it is not possible to track down individual participants' visits to the EfS website *Lanalhue Sustentable*.

Another limitation is that Google Analytics records every visit to the EfS website. In the case of the intervention period, besides the twenty-four participants only four other persons had access to the EfS website: the web designer, the researcher, and the 2 research supervisors. Excepting the web designer, the researcher and supervisors also visited the EfS website during the intervention period.

This means that in some cases, and particularly for the day-level data from the Content Overview, data retrieved from GA that ideally would

exclusively represent participants' use of the website as a sole cohort is not 100% accurate as it also includes visits from the researcher, supervisors, and maybe afterhours participants. In some cases analytical treatment to overcome this issue was possible, for example, in both reports it was possible to exclude the 2 supervisors from the data set based on their location. Altogether, the researcher's view is that, for the purpose of this study, the overarching findings drawn from this quantitative set of data overcome these analytical issues. Discussion on this matter follows below when required.

6.3.1.1 EfS website Visits Overview

One type of standard analysis provided by Google Analytics (GA) is the 'Visits Overview', where a general panorama of the visits to a site is presented. The Visits Overview for the EfS website during the intervention period reported by GA indicates that the website received 66 visits from 27 people, or '*unique visitors'*, including in total 655 '*pageviews*'. Pageviews is a GA term to indicate the total number of pages viewed (i.e. repeated views of a single page are counted). The term *visits* is defined by GA as "the number of visits to your site", whereas a *unique visitor* is defined as "the number of unduplicated (counted only once) visitors to your website over the course of a specified time period" (Google Inc., 2012). Therefore a visitor may be counted as visiting the website more than once (i.e. hence the higher number of visits compared to the number of unique visitors).

Figure 6.1 presents a Visits Overview diagram from Google Analytics indicating the number of visits during the intervention period. Based on the time at which each intervention took place, it was possible to determine those visits that correspond to participants' visits (i.e. hour-level detail), indicated by the dark areas on the diagram. The other visits correspond to researcher and supervisors' visits to the EfS website during the intervention period. As well, some participants may have re-visited the website after their first visit during the intervention but still within the intervention period, as some of them expressed their willingness to do so

and the website was available online to anyone with the right URL (i.e. website address).

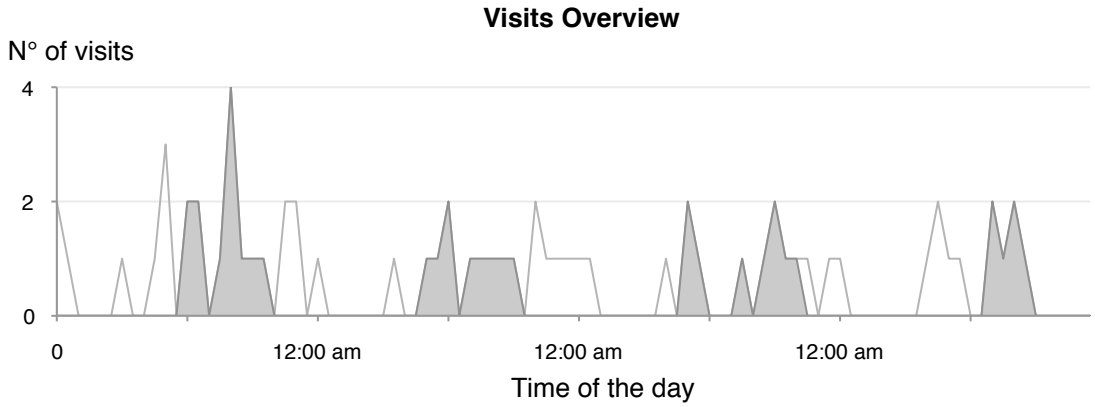

Figure 6.1. Number of visits over time of the day during the intervention period (from 7th to 10th of March 2011). Dark-shaded areas represent visits made by participants (phase 4b; source Google Analytics).

Data from Table 6.5 presents GA key metrics corresponding to participants' visits to the EfS website during the intervention period. Note that some values from Table 6.5 (i.e. indicated with an *) are approximated values, as they were calculated using the online version of the diagram from Figure 6.1, where it is only possible to retrieve data at the hour-level detail. Figure 6.2 shows a participant visiting the EfS website during the intervention.

Table 6.5. General overview of participants visits during the intervention period (n = 24; source Google Analytics).

Visitors	Visits	Unique visitors	Pageviews	Pages / visit	Average visit duration
Participants	36	24	440*	12.2*	00:14:49*

(*) Approximated value due to low resolution of data from Google Analytics (value expressed in *hours: minutes: seconds*).

Values from Table 6.5 correspond to average figures of the cohort, and thus serve principally as referential information. It can be said that, on

average, participants spent around 15 minutes per visit and visited over 10 pages (of a total of 48 pages). Nonetheless, some participants browsed the website for more than 20 minutes, i.e. up to 40 minutes in the case of Romina, whereas other participants browsed the website for less than 10 minutes (e.g. Emilio), depending on motivation and time availability. Hence, the average time of 14:49 minutes per visit is regarded here only as a referential value.

Figure 6.2. A participant visiting the EfS website. Note the participant is watching a video about the harvesting of the aquatic plant *Egeria densa*. He commented, “What can I say? I am enchanted to know that this website exists!” (Manuel, post website use interview, *seq.* 201.01).

Similarly, the number of pageviews per visit (i.e. pages/visit metric) also represents an average for the cohort. Some participants may have been more inclined to do an in-depth reading of texts, hence spending more time on a page and visiting fewer pages than the average, whereas other participants may have preferred to scan through different pages instead, visiting more pages per visit. As well, some participants may have visited pages with more text than other pages, depending on their navigation route, thus visiting fewer pages in total than the average. On the whole, the key point to highlight here is that all participants were able to access the EfS website at their comfort and in a familiar setting. This approach overcomes in part the analytical issue of data validity due to the low resolution of data from Google Analytics (i.e. for values indicated with an *

from Table 6.5), as statistical precision becomes then meaningless under the scope of qualitative interpretation.

6.3.1.2 EfS website Content Overview

Another standard report from Google Analytics is the Content Overview, which gives information on the content of a website visited over time. In the case of the EfS website, the website contained 48 different possible pages to visit at the time of the intervention, grouped under 10 principal sections and 6 secondary sections. Table 6.6 below shows each one of these sections with a brief description of their objective and/or purpose; followed by Figure 6.3 that presents the Home page organization and accessibility structure of the 23 pages accessible from the Home page.

Table 6.6. Principal and Secondary sectiuons of the EfS website.

Section	Objective / Purpose
Principal Sections	
b. Lanalhue Lake	Presentation of general aspects of Lanalhue Lake.
c. Sustainability	Introduction to general concepts of sustainability and local context.
d. Luchecillo	Addresses range of aspects related to the eutrophication of the lake.
e. Solutions	Presents a range of possible solutions to local sustainability issues.
f. Questions & Answers	Addresses common misconceptions and alternative conceptions related to the lake (i.e. previously identified).
g. Documentation	Section containing all information obtained related to Lanalhue Lake.
k. Multimedia	Photos and videos to showcase range of Lanalhue Lake's issues.
o. Articles	Section with collaborators' articles about lake / sustainability issues.

Section	Objective / Purpose
p. Local & Global Experiences & Examples	Presents a range of local and global experiences and examples related to the lake, eutrophication and/or to sustainable living.
q. Mapuche Worldview	Presents local Mapuche culture knowledge and worldview (indigenous knowledge).
Secondary Sections	
h. Social Media	Access to EfS website's social media sites.
l. Participate	Invitation to participate and collaborate with the EfS website.
m. Subscribe	Subscription to *Lanalhue Sustentable*'s Newsletter.
u. Links	Access to a range of local and global sustainability-related websites.
v. Credits	Credits and acknowledgements.
w. About this site	Brief description of the EfS website.

Sections' codes relate to Figure 6.3 and Table 6.7 below.

Table 6.7 presents the Content Overview for the 23 pages accessible from the Home page of the EfS website (i.e. including both principal and secondary sections, and subsections), and the average time spent on each page per visit. Note that all entries to the EfS website by participants were through the Home page.

Excepting the Home page itself with 161 pageviews, the top 5 most visited pages accessible from the Home page are all mainly related to local sustainability issues, in particular to the eutrophication of the lake, representing over 50% of the total pageviews accessed from the Home page (i.e. total pageviews accessible from the Home page = 320, without considering the 161 Home page pageviews). The most visited page is the Questions & Answers (Q&A) section (i.e. 38 pageviews, representing 11.9% of the total pageviews), which directs to three categories of Q&A:

Q&A about Luchecillo and Eutrophication (i.e. 24 pageviews); Q&A about Biodiversity (i.e. 14 pageviews); and Q&A about Sustainability (i.e. 8 pageviews; note that the sum of Q&A categories do not sum the total of 38 pageviews, as some of these were directly accessed through a lateral menu).

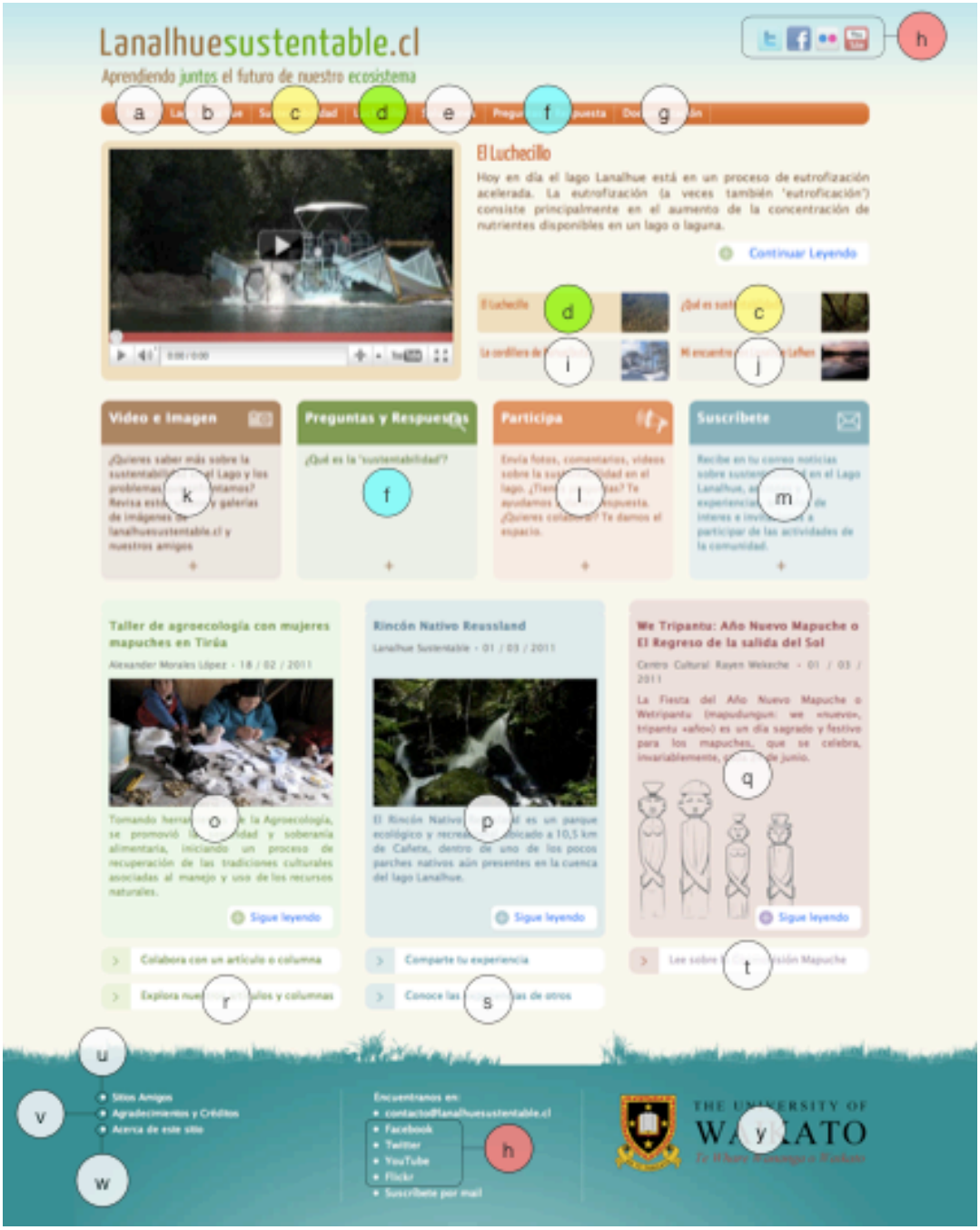

Figure 6.3. Structure and organization of the Home page of the EfS website, and accessibility to the different sections. Colours indicate sections that are repeated on the Home page.

Table 6.7. Content Overview for all sections accessible from the Home page of the EfS website (i.e. n = 23 pages).

Page Title	Pageviews	Avg. Time on Page (hr: min: sec)	Code
1. Home *Lanalhue Sustentable*	161	00:01:26	a
2. Questions & Answers - All	38	00:00:14	f(*)
3. The Luchecillo	35	00:04:20	d(*)
4. Lanalhue Lake	32	00:01:08	b
5. Solutions - All	30	00:00:17	e
6. Documents - All	28	00:00:38	g
7. What is sustainability?	26	00:01:15	c(*)
8. Videos and Photos (Multimedia) - All	20	00:03:39	k
9. Local and Global Experiences and Examples - All	19	00:01:06	s
10. Articles - All	14	00:00:33	r
11. Social Networking links	13	-	h(*)
12. Credits & Acknowledgements	12	00:04:06	v
13. Participate & Collaborate	11	00:00:22	l
14. Mapuche Worldview - All	11	00:00:50	t
15. Links to websites of interest	8	00:01:08	u
16. Local and Global Experiences and Examples - Reussland Native Park	6	00:01:00	p
17. Mapuche Worldview - We Tripantu	5	00:01:01	q
18. Lanalhue Lake - Nahuelbuta Range	4	00:00:30	i

Page Title	Pageviews	Avg. Time on Page (hr: min: sec)	Code
19. Article - Workshop on Agroecology with Mapuche Women	4	00:01:07	o
20. Mapuche Worldview - My encounter with Lanalhue Lafken	2	00:01:25	j
21. Subscribe	2	-	m
22. About this site	0	-	w
23. University of Waikato link	0	-	y

(*) Indicates sections that are repeated twice on the Home page (i.e. coloured circled-codes from Figure 6.3; source Google Analytics).

The Q&A section was designed to address misconceptions and alternative conceptions related to local issues identified during the Conceptions survey (i.e. phase 2b, pre-design research phase), under the EfS theoretical premise of actively challenging beliefs and misconceptions held at the local level (Aronson, 2007; Ballantyne & Packer, 2005; Menzel & Bögeholz, 2008). So the fact that this section that was precisely designed to challenge local beliefs received so much attention, suggests that this may have contributed to challenge participants' misconceptions and alternative conceptions, if they held any.

The second most visited section accessible from the Home page was The Luchecillo page (i.e. code d in Figure 6.3), with 10.9% of pageviews. As well, this section was the one with the highest average time on page of all the 48 pages of the EfS website, i.e. 00:04:20 minutes on page per visit on average. As this is the principal topic addressed in the EfS website, the fact that participants showed a high interest towards this topic suggests, at this point, that the set of different considerations from the theoretical model to make this topic attractive and/or meaningful to participants may have worked well. Note that the top 2 most visited pages are also pages that are represented twice in the Home page, which increases the probability of participants visiting them, this being one of the objectives of

the design process: to direct visits towards principal sections and locally relevant and meaningful pages.

The third and fourth most visited pages from Table 6.7 are the Lanalhue Lake and the Solutions sections, with 10% and 9.4% of pageviews respectively. The Solutions section directs to two subsections: Solutions by local individuals, organizations and experts, and Solutions by *Lanalhue Sustentable*. This last page has the second highest average time on page, i.e. 00:04:11 minutes on page per visit. Finally, the last most visited page of the top five group is the Documents section with 8.8% of pageviews. This section directs to four subsections or categories of Documents; Table 6.8 presents these sections indicating pageviews and average time on page, with the top two Documents subsections also related to local issues (i.e. as they deal with the Luchecillo issue, and information on Lanalhue Lake). In addition, GA reports that 3 documents were downloaded during the intervention period: Predatory Birds of Nahuelbuta Range (i.e. the natural environment surrounding Lanalhue Lake; 3 downloads); Lanalhue Lake Commission Report (i.e. 3 downloads); and Pro-Lanalhue Lake Commission (i.e. 1 download). As all these downloads are related to Lanalhue Lake's information and/or sustainability issues, the fact that they received more attention over other non-local documents confirms, again, a tendency towards local matters.

Table 6.8. Content Overview for the Documents section (code g).

Code	Page Title	Pageviews	Avg. Time on Page*
g.1	Documents - Luchecillo	10	00:02:10
g.2	Documents - Lanalhue Lake	8	00:01:38
g.3	Documents - Local and Global Experiences and Examples	7	00:00:47
g.4	Documents - Sustainability	3	00:00:11

(*) Value expressed in *hours: minutes: seconds*.

Following the top 5 most visited pages reported above (i.e. first group of most visited pages), the second group of most visited pages, representing around 37% of the total pageviews, is rather characterised by being related to general topics, and to some web affordance features such as multimedia and social networking. The most visited page from this group is the 'What is Sustainability?' section with 8.1% of pageviews. This section addresses the general concept of sustainability and its implications at the local level in relation to the eutrophication of the lake, as the concept of sustainability is a key concept within the EfS website. The next two most visited pages in this group were two sections related to web affordance features. The first of these corresponds to Web 2.0 and social networking sections with altogether 6.6% of pageviews, which include the Social Networking section (i.e. code h in Figure 6.3; 13 pageviews) with links to the EfS website's associated system of Web 2.0 sites (i.e. Facebook, Twitter, YouTube, and Flickr), and the 'Links to Websites of Interest' section (i.e. code u in Figure 6.3; 8 pageviews) that promotes networking among similar websites. The second of these web affordance features was the Video & Photos (i.e. Multimedia) section with 6.3% of pageviews.

Following the Social Networking and Video & Photos sections, in fourth, fifth and sixth place of most visited pages (i.e. still of the second group of most visited pages) come the Local and Global Experiences and Examples section with 5.9% of pageviews, the Mapuche Worldview section with 5.6% of pageviews (i.e. this is the sum of pageviews of the three Mapuche Worldview pages accessible from the Home page: codes t, q and j), and the Articles section with 4.4% of pageviews. As stated above, these sections and related pages include a variety of topics, where the aim is to provide EfS website users a broad range of information about real-life and sustainability-related issues, including both local and non-local aspects.

This design approach is based on two key community education (CE) concepts: (1) 'relevance and meaningful knowledge', meaning that CE mainly deals with community's needs, problems and locally rooted issues

(Nomura, 2004; Thompson, 2002; Tilbury & Wortman, 2008); and (2) 'broad audience', which is the fact that CE generally involves a broad audience, thus demanding a wide range of variety, intensity and sophistication of information (Brookfield, 1990; Menzel & Bögeholz, 2008).

The last group of most visited sections and pages accessible from the Home page included all the secondary sections from Table 6.5 (i.e. excepting the social media category), plus 3 subsections pages showcased on the Home page (i.e. all originally from different sections). The pageviews for this third group represent the remaining 12% of the total pageviews.

In regard to data validity of the Content Overview, as mentioned earlier Google Analytics only provides day-level data for this report, making it impossible to isolate participants' individual visits and pageviews. Google Analytics reports that during the intervention period the EfS website received 66 visits from 27 unique visitors, including a total of 655 pageviews, of which 53 are from visits outside Chile (i.e. supervisors' visits). Of the remaining 602 pageviews, 440 pageviews (i.e. approximated value based on hour-level data from the Visits Overview report) correspond to the 24 participants (i.e. of which 320 were accessed from the Home page), and the remaining 162 pageviews correspond to researcher's visits, and possibly to some participants' visits made outside the intervention time but during the intervention period, as reported earlier.

This means that the above Content Overview analysis does not exclusively account for participants' pageviews, but also includes pageviews made outside the researcher's control during the intervention period. So, although it is clear there were non-participant visits, analysis shows that this does not affect the overall participants' distribution and percentages of pageviews reported above. Moreover, in the case of possible visits made by participants after the intervention time but during the intervention period, these would only reflect the real interest of

participants towards the EfS website and its content, hence contributing to the final participants' distribution shape of pageviews.

Despite this, the fact is that it is not possible to have a Content Overview report accounting only for participants' 440 pageviews. However, triangulation of data from Google Analytics with qualitative data from the post-intervention interviews (i.e. phase 4c) and from the follow-up survey (i.e. phase 4d) is possible and can assist in supporting or not the above findings regarding the Content Overview. Such qualitative data follows in the coming sections.

6.3.2 Participants' perceptions of the EfS website

Perceptions of the EfS website by participants were assessed by means of open-ended questions asked at the start of the post-intervention interview, immediately after their first visit to the EfS website. Questions asked of participants dealing with their perceptions of the website were the following:

- Q1. What do you think of the website?
- Q2. What aspects of the website do you like / not like? Why?
- Q3. Are there any aspects of this website that you would change or improve? Why?

Answers to these questions were analysed using theme code 15.00 of the Codebook, i.e. 'Participants perceptions of the EfS website lanalhuesustentable.cl', and were grouped under three categories: 'general perception of the EfS website' (*theme code* 15.05); 'opinion about particular aspects of the website' (*theme code* 15.10); and 'website aspects to add or change' (*theme code* 15.20).

6.3.2.1 General perception of the EfS website

Answers to question Q1 'what do you think about the website?' show a good reception and a positive perception of the EfS, with 21/24 participants providing data for this question. Data from answers were coded under six subthemes, with the most recurrent subtheme being the

view that ‘the website is interesting because it deals with locally relevant and meaningful issues’ (*theme code* 15.070), with 16/21 participants scoring under this category (see Table 6.9). The second most recurrent subtheme, with 10/21 participants scoring, is the opinion that ‘the website has a clear message, is easy to understand, and is ‘attractive’’ (*theme code* 15.065). The third most recurrent subtheme, with a 7/21 of participants scoring, is the opinion that ‘the website is a contribution towards the sustainability of Lanalhue Lake’ (*theme code* 15.075).

Table 6.9. Participants’ general opinions about the EfS website (n = 21, *theme code* 15.05).

Subtheme	**N° of participants**
Website deals with locally relevant and meaningful issues (i.e. ‘interesting’)	16
Website has a clear message, is easy to understand, and is ‘attractive’	10
Website is a contribution towards the sustainability of Lanalhue Lake	7
Liked the website very much	4
First website to address Lanalhue context	2
Found the website motivating	1

In an overview of the general perceptions of the EfS website by participants, data indicate that at least three key theoretical considerations for the design of EfS websites are related to answers to Q1, and thus may be regarded as part of the EfS website lanalhuesustentable.cl. From community education theory (CE), two key considerations are: (1) ‘the importance of clearly defining and addressing the social and cultural needs of the target community’, and (2) the inclusion of ‘relevant and meaningful knowledge to the target community’ (Dunn & Marinetti, 2008; Knight et al., 2009; Thompson, 2002). Participants were strong in their

belief that the website dealt with locally relevant and meaningful issues (n = 16), in what can be considered a manifestation of community education theory by participants regarding the EfS website. For example, Javiera outlined the connections to the Mapuche and women:

> I think it is excellent! I think it is excellent because it deals with different issues that are related to the lake, and actors that are directly involved, like for example I saw the Mapuche issue, the topic about women that work on agriculture but within a conservation scope. So I think it is interesting, I couldn't check it more but I will definitely visit the website regularly.
>
> (Javiera, post website use interview, *seq.* 189.02)

Another participant, Julia, highlighted the connections made in the website for creating awareness about local issues:

> Very interesting, it addresses many issues that are of interest for the youth, for myself, and for the people from Cañete and its surroundings. These are interesting topics because they help us with creating awareness among people, awareness that we need so much these days because we are destroying our ecosystem, the flora, the fauna, and our water resources.
>
> (Julia, post website use interview, *seq.* 180.01)

Concerning the third theoretical consideration for the design of EfS websites, ICT theory indicates that during the design process of EfS websites, affordances like 'good navigation and accessibility' must be considered, included and maximized, in order to provide an attractive website with a clear message (Greenhow et al., 2009; Webb, 2005). Many participants also commented on the clear messages of the website, making it easy to understand (n = 10/21). For example, Ana said:

> I really liked it, to say the truth I don't know much [about ICT/websites]; it's a website with the necessary information that one needs, and it's understandable, it goes step by step, and one can understand what the website wants to show, I understand it.
>
> (Ana, post website use interview, *seq.* 209.01)

In addition, four participants indicated that they 'liked the website very much' (*theme code* 15.055), as Manuel commented, "What can I say?! I am enchanted to know that this website exists!" (post website use interview *seq.* 201.01; see Figure 6.2). Doris said that she found the website to be very motivating for her (*theme code* 15.060); and two participants, Ramiro and Mario, stated that the EfS website is the first and only website dedicated to address the ecological issues present at Lanalhue Lake that they were aware of (*theme code* 15.080). In particular, Mario said:

> I think the real merit and value of this website is that it is the first website dedicated to protect the Lanalhue Lake, which is something never done till this moment; it has an identity of protection over the lake.
>
> (Mario, post website use interview, *seq.* 179.02)

From these responses, it can be inferred that the website appeared to address meaningful and relevant issues to local community members. Similarly, the website appeared to present a clear and understandable message, and to be 'attractive' in many ways, at least for some of the participants.

6.3.2.2 Opinion about particular aspects of the EfS website

In the case of particular aspects of the EfS website that were meaningful to participants, answers to question Q2 'what aspects of the website do you like / not like? & Why?' come from twenty-two participants, and include seven recurrent subthemes. Table 6.10 presents these subthemes, indicating the number of participants scoring under each one.

All the answers to Q2 are aspects of the EfS website that participants '*did like*', and no answer relates to aspects that participants '*did not like*', indicating again a good reception of the EfS website by participants, in this case regarding particular aspects of the website. The most recurrent aspect, or subtheme, pointed out by thirteen participants, is that 'the website has good and broad information (i.e. reliable and holistic)' (*theme*

code 15.115). In second place of recurrence, three particular aspects of the EfS website were highlighted, each one by six different participants: the 'inclusion of the Mapuche worldview in the website as positive aspect' (*theme code* 15.105); the opinion that 'the website has a good structure and organization of its elements' (*theme code* 15.120); and the opinion that 'the website has a good visual design and graphical quality' (*theme code* 15.125).

Table 6.10. Participants' opinions about particular aspects of the EfS website (n = 22, *theme code* 15.10).

Subtheme	**N° of participants**
Website has good and broad information (i.e. reliable and holistic)	13
Inclusion of Mapuche worldview as positive aspect	6
Website has a good structure and organization of its elements	6
Website has a good visual design and graphical quality	6
Website as a good accessibility and navigability	3
Everything / all aspects are good	3
Website is interactive	1

Data related to the most recurrent subtheme for Q2 (*theme code* 15.115 'website has good and broad information'), indicates that an important aspect of the EfS website for participants is the fact that the website presents a good and wide range of information, with variety in depth, and diversity in sources of information. This can be seen, as the materialization of another community education (CE) theoretical consideration for the design of EfS websites: to consider the target audience as a 'broad audience', meaning that such an audience comprises a wide range of existing conceptions and needs, thus calling for the inclusion of a wide range of types of information (i.e. sources, sophistication and depth of information) (Brookfield, 1990; Menzel & Bögeholz, 2008).

Many of the participants that scored under this most recurrent subtheme highlighted the fact that the website contained a ‘great amount’ of ‘reliable’ and ‘quality’ information. In addition, some participants also indicated some potential use of the website to enhance their activities. For example, Ramiro, a secondary teacher, pointed out the pedagogical value of the website for his students:

> There is a lot of information, a lot of information, it’s a great website for the students, for their history and geography classes, for their biology classes when they talk about the eutrophication and environmental problems, I like it!
>
> (Ramiro, post website use interview, *seq.* 193.03)

Other participants, like Oscar and Rafael, were very surprised to find on the website information about the lake that they thought did not even exist. Oscar said “It seems to me like a compilation of much knowledge that I didn’t even know existed, about the lake and its environment” (post website use interview, *seq.* 186); whereas Rafael pointed to the lack of existing information prior to the EfS website, among other things:

> The website really has a lot of things, including Mapuche worldview, and I like to learn about the place where I live. I know I will keep revisiting it, because it has a lot of documents and is very thorough. This project and website are great, not even in the council’s website you can find information like this, all I knew was from word of mouth as I always ask people, but here there is even a scientific background on many subjects.
>
> (Rafael, post website use interview, *seq.* 198.03)

Another view is the one provided by Ernesto, who mentions and appreciates that the information contained in the EfS website offers a ‘wider’ view: “I like that the people involved with the website, for example, in the Questions & Answers section, are people with a broader view of the environmental issues” (post website use interview, *seq.* 219). This can be linked to theoretical considerations coming from systems thinking (ST) and education for sustainability (EfS) that stress the importance of

understanding the wider relationships of sustainability issues, and to be able to present this 'big picture' to learners in a meaningful way (Center for Ecoliteracy, 2009; Orr, 2004; Sterling, 2001).

One of the second most recurrent subthemes (i.e. out of three) relates to cultural aspects, with six participants indicating that the inclusion of the Mapuche worldview in the website was something positive that they liked to see. Javier, a non-Mapuche participant originally from Santiago, stated:

> The website contains all the elements that are of interest to me, in fact it also includes the cultural aspect, which I found to be very interesting, as it is a topic that one maybe doesn't expect to see on a website exclusively dedicated to the environment. To include and consider the Mapuche worldview, which is not a minor topic, I think is a great decision.
>
> (Javier, post website use interview, *seq.* 216.01)

This cultural aspect of the website is rooted in CE and EfS considerations, in that it is important to address the social and cultural contexts of the target community, and that it is important to include local / indigenous knowledge and perspectives, respectively. In the Lanalhue Lake context, this means to be aware of the larger cultural-historical aspects, this area of Chile being well known as a historically important Mapuche area. Then, for some participants like Javier and Rafael (i.e. both non-Mapuche), the inclusion of this aspect in the website was significant and meaningful while addressing the sustainability issues present at Lanalhue Lake.

The two other aspects of the EfS website defined as second most recurrent subthemes (i.e. also highlighted independently by six participants as something relevant to them), are aspects related to ICT considerations, in particular to the type and quality of affordances offered by the website. One of these affordances relates to the structure in terms of the function of the website, as pointed out by Mario:

> I think the website is well designed, in terms of what is needed to know, what it aims to show, it has the necessary menus, and I think it invites the user to understand the objective of the website.
>
> (Mario, post website use interview, *seq.* 203)

Another similar aspect is the one mentioned by Mateo, in regard to the organization of the website, as he states:

> What I did like is that I feel like the website is really organized. You can go to the Menu bar and can find 'Home', 'Lanalhue Lake', 'Sustainability', 'Luchecillo', 'Solutions', 'Questions & Answers', 'Documentation', etc…
>
> (Mateo, post website use interview, *seq.* 387)

In addition to the affordances mentioned above, and as pointed out in Section 6.3.1.2, the use of multimedia such as animations, pictures and videos, is another key consideration for the design of meaningful EfS websites. Ramiro pointed out the good quality of photos on the website:

> I really liked the colours, it's attractive, I love the photography quality. I think this achieves, from my point of view, a good objective, because if you have bad quality photos and bad quality videos it is not attractive, and one can lose interest easily, but here it is not the case.
>
> (Ramiro, post website use interview, *seq.* 193.02)

Also concerning the colours of the website, Julia stated "Well I am a very sensitive person, so I loved the colours, it gives me like tranquillity, harmony… The website doesn't feel like tiring, because of the colours, it is very friendly" (Julia, post website use interview, *seq.* 204.01). Moreover, Javier, Pablo and Julia stated that 'the website has a good accessibility and navigability' (*theme code* 15.110); and Emilio indicated that the website was "very interactive" (*seq.* 191.01; *theme code* 15.130). These responses indicate that for a significant group of participants (n = 16), the EfS website includes a range of meaningful affordances, resulting in a more friendly website-user experience. Note that theory highlights that such affordances need to be maximized during website design, and are

finally shaped by the designers and users' own social, cultural and historical backgrounds (Dohn, 2009). Finally, in a general perspective of the website, Romina, Marisol and Benjamin pointed out that for them 'all the aspects of the website were good' (*theme code* 15.135).

6.3.2.3 Website aspects to add or change

The third question of the post-intervention interview dealing with participants' perceptions of the EfS website explored aspects of the website that participants found they would like to change or improve. From a total of 24 participants, 11 were asked question Q3 as part of their post-intervention interview: 'Are there any aspects of this website that you would change or improve? & Why?'. Note that the remaining participants were not asked question Q3, either because the interview developed itself in a way that it was not pertinent to ask it, or because of time constraints that demanded shorter interviews due to participants' time availability. In addition, 3 participants that were not asked question Q3 still provided input on this matter through question Q9 'would you like to add a final comment?', with a final total of 14/24 participants providing input regarding website aspects to add or change, and with seven recurrent subthemes identified. Table 6.11 presents these seven subthemes identified for question Q3.

From the seven subthemes identified for Q3, two of them are not related to things that respondents would add or change: theme code 15.220 'nothing to change, website is good' (n = 4; this being the most recurrent subtheme), and theme code 15.225 'need more time to evaluate the website' (n = 3). For the remaining recurrent subthemes, three main categories of things to add or change have been identified: (1) visual affordances, (2) tourism-related affordances and information, and (3) local actors-related information. In regard to the visual affordances aspect, Romina and Pamela noted that the website 'needs drawings and cartoons to make it more attractive for children' (*theme code* 15.205). In Romina's own words:

> I would add, not change, but add some drawings for children, so the website can be used by all kinds of person, from adults to kids, to include some cartoons for the kids.
>
> (Romina, post website use interview, *seq.* 225)

Table 6.11. Participants' opinions about website aspects to add or change (n = 14; *theme code* 15.20).

Recurrent subthemes for Q3
Nothing to change, website is good
Need more time to evaluate the website
Website needs components (i.e. drawings, cartoons) to make it more attractive to children
Website needs more graphical attractiveness (i.e. photos)
Include more local actors that are relevant
Website could include information on other smaller lagoons and waterfalls around Lanalhue Lake
Website translated into other languages for an easier access to international visitors

The other aspect related to visual affordances is the one raised by Mario and Benjamin, this time the 'graphical attractiveness' of the website (*theme code* 15.210). Mario specifically mentioned adding more photos to the website: "Maybe I would include more photos, more friendly, may be that, I think the website is OK" (Mario, post website use interview, *seq.* 223). Whereas Benjamin further reflected on how people use a website in relation to its visual attractiveness:

> I would improve it by making it more graphical to the eye. I think people don't read, people are not used to read, so too much reading makes people get distracted and start visiting other websites, so I think the website can be improved with more photography and short texts.
>
> (Benjamin, post website use interview, *seq.* 188.02)

In regard to the first 'missing' visual affordance pointed out by Romina and Pamela, this may be understood from their particular backgrounds, as both participants are normally in contact and work with children (see Section 6.2.1 'Participants' profiles and demographic characteristics'): Romina is a primary teacher at a local school, where she is in charge of the school's science academy, giving great focus to the environment; and Pamela has for a long time been part of a local environmental NGO that carries out important environmental action with children and teenagers. Although the issue raised by both is totally relevant from an EfS point of view, the scope of the EfS website is to aim at the 'adult' section of the target community (i.e. all audience from 16 years old and over), and thus such visual affordances fall outside the educational objective of the EfS website.

In a similar way, the other visual affordance issue raised by Benjamin and Mario also can be interpreted from their particular backgrounds: both participants have a high level of ICT knowledge and are regular Internet users, meaning that they know the value of having a website "more graphical to the eye" over having one with too much text, as stated by Benjamin (*post website use interview*, *seq.* 188.02). In addition, Mario is a local photographer, thus, arguably, it can be said that his background influenced his perception and likeliness of including more photography on the EfS website, which in fact, according to the literature is a key element to enhance the overall affordances provided by a website (Mayer & Moreno, 2002).

In regard to the second aspect to add or change identified from answers, from a local tourism information point of view Benjamin also suggested that the 'website could include information on other smaller lagoons and waterfalls' that are close to Lanalhue Lake (*theme code* 15.230), and Ana said:

> I would like to see lanalhuesustentable.cl reaching everywhere, at a national level, and hopefully one day it may be translated to other

languages, to make it easier for international people to get to know the lake and visit it.

(Ana, post website use interview, *seq.* 403)

And finally, for the third aspect related to 'local-actors' identified from answers, Javiera stated:

Maybe I would add more local actors, environmental groups that may be too passive now and that could be reactivated, authorities, and public services… That is something I would like to see.

(Javiera, post website use interview, *seq.* 229)

Concerning these two last categories of aspects of the EfS website to add or change, i.e. tourism-related affordances and information as raised by Benjamin and Ana, and local actors-related information pointed out by Javiera, it can be inferred that such answers also come from their social background: Benjamin and Ana are local business people associated with the tourism industry, and Javiera works in a government agency that deals with the environment, thus knows about the existence of a wide range of likely organizations and institutions that could be part of the EfS website, and understands the significance of involving more local actors when dealing with environmental issues.

Overall, it is safe to say that data from this subsection fits the theory, in that, from a community education point of view, people pay attention to what is meaningful to them (Brookfield, 1986; Thompson, 2002), and in turn what appears to be meaningful to people, according to Activity Theory, is shaped by their socio-cultural role and background (Cole & Engeström, 2001; Yamagata-Lynch, 2007).

6.3.2.4 Participants' last comment about the EfS website

In addition to the 3 questions asked of participants at the start of the post-intervention interview related to their perceptions of the EfS website (i.e. Q1, Q2 & Q3), a final question, i.e. Q9 'would you like to add a final

comment?', was asked of participants in order to give them the chance to express any last thoughts regarding the EfS website, the interview itself, or any other aspect that they were willing to highlight. Moreover, such an open question invited participants to reflect on the whole intervention experience, and gave the researcher the opportunity to explore what appeared to be meaningful to participants. Answers to Q9 were categorized using theme code 19.00 of the Codebook, i.e. 'Participants' last comment from post intervention interview', and were grouped under two categories: 'last comment about the EfS website' (*theme code* 19.05; n = 10), and 'last comment about the educational project Lanalhue Sustentable' (*theme code* 19.10; n = 12). Here, only answers from the first category are presented, as they are the ones related to participants' *perceptions* of the EfS website. Six recurrent subthemes were identified for theme code 19.05. Table 6.12 presents these recurrent subthemes.

Table 6.12. Participants' last comments about the EfS website (n = 10, *theme code* 19.05).

Recurrent subthemes for Q9
Liked the website
Motivation to re-visit the website
Motivation to disseminate the website among relatives and friends
Website is good for information access
Website as a start point for coming initiatives related to Lanalhue lake
Website needs to include tourism aspects

From the six recurrent subthemes identified from answers to Q9, three of them can be related to general or particular aspects of the EfS websites that have already been mentioned by participants in previous subsections. These are: (1) subtheme 'liked the website' (*theme code* 19.055), mentioned both by Marisol and Mariana as a last comment, is similar to subtheme 'liked the website very much' from Section 6.3.2.1 'General perception of the EfS website', mentioned by 4 participants; (2) subtheme

‘website is good for information access’ (*theme code* 19.070), mentioned by Oscar and Rafael, can be related to subtheme ‘website has good and broad information (i.e. reliable and holistic)’ from Section 6.3.2.2 ‘Opinion about particular aspects of the EfS website’, which was the most recurrent subtheme for Q2 with 13/22 participants scoring; and (3) subtheme ‘website needs to include tourism aspects’ (*theme code* 19.080), mentioned by Mateo, can be associated to subtheme ‘website could include information on other smaller lagoons and waterfalls around Lanalhue Lake’, mentioned by Benjamin as an answer to Q3 in regard to aspects of the website that participants would add or change (i.e. Section 6.3.2.3). Mateo’s last comment reaffirms the fact that to include information about tourism aspects related to Lanalhue Lake and its surroundings on the EfS website appears as something relevant, at least for two of the participants.

The other three recurrent subthemes, which cannot be related to previous recurrent subthemes and thus can be taken as a new type of answer prompted by Q9, can be grouped in two categories. First, subthemes ‘motivation to disseminate the website among relatives and friends’ (*theme code* 19.065, n = 2), and ‘motivation to re-visit the website’ (*theme code* 19.060, n = 2), are both a type of *motivation*. From an Activity Theory (AT) perspective, these motivations generated from the interaction between the website and participants can be taken as an *outcome* of such an activity system. On the other hand, theory states that motivations, along with the subject, object, tools, goals, and socio-historical context, are what regulate activities in an activity system (Yamagata-Lynch, 2007).

Hence, the outcome of having a motivation to re-visit or to disseminate the website, that resulted from the use of the EfS website by these four participants, can in turn become part of a new activity system, in what literature calls a third generation activity theory (AT) expansive system, where the outcomes of one activity system are used by other activity systems to reach other goals (Krasny & Roth, 2010). In other words, the EfS website could be regarded, in this case, as part of a dynamic and

expansive activity system, nurtured by the EfS website itself. Another point regarding motivations is that, as reviewed in Section 2.4 of the literature review, opportunities provided by technology (i.e. in this case by the EfS website), such as the motivation to carry out further actions based on the use of the EfS website, also indicates meaningfulness and relevance of the website (Dohn, 2009; Webb, 2005; Woo, 2009), at least to this group of participants in particular.

The second category of recurrent subthemes from Q9 that cannot be related to earlier answers includes the sole comment made by Emilio regarding the role of the EfS website for future actions related to Lanalhue Lake (*theme code* 19.075):

> The website should be taken as a start point for future actions. I think that the integration of all stakeholders and lake's inhabitants has to be done in the short term, but it needs to include concrete actions. I believe there are studies to support that, there is a lot of research already, what we need to do now is to act.
>
> (Emilio, post website use interview, *seq.* 409)

At least two things need to be highlighted from Emilio's last comment. In the first place, one of the EfS objectives of the website, besides promoting *understanding* and *action* around Lanalhue Lake issues, is to promote *social engagement in sustainability* (*theme code* 1.125). Emilio's last comment points towards that direction, in that he recognizes the need for a social integration at the local level for the wellbeing of the lake.

Of interest is that he puts the EfS website at the centre of such a process, which brings attention to the second point: based on education and complexity theory literature (Morrison, 2002). As pointed out in Section 6.3.1.2, the theoretical model for the design of EfS websites developed as part of this study defines an EfS website as an educational *facilitator* (*theme code* 6.080), implying that an EfS website should aim to act as a *leader* in the sense of being an empowering agent that shows the way towards ecological sustainability. This call is further supported by answers

related to the capacity of the EfS website to provide good and reliable information, in other words, to prompt information access and flow as an educational leader would do, in the view of complexity theory (Morrison, 2002).

Findings from this subsection indicate that, from an AT and complexity theory point of view, the EfS website presents, at this stage, some characteristics of a dynamic educational system: it is a system that can reinforce and expand itself, and it is pedagogically meaningful, both in terms of its contents and in terms of its outcomes. More findings and discussion on this matter follow in the coming chapters.

6.3.3 Summary

As a summary of Section 6.3, in regard to the use of the EfS website by participants as a cohort, quantitative data from Google Analytics indicates a preference and tendency to visit and browse those sections and pages related to local sustainability issues. Principally, preferences were around those website sections dealing with the main sustainability issue addressed by the EfS website: the eutrophication process occurring at Lanalhue Lake. In addition, other website sections and features highlighted in the literature as important components of an EfS website, such as Web 2.0, social networking, and access to a broad range of information regarding local and non-local sustainability issues, also showed good attention by participants.

On the other hand, qualitative data from post intervention interviews indicate that the website was highly meaningful and relevant to participants. In addition, the website appeared to participants to be well designed in terms of attractiveness, clarity, and accessibility, indicating a good maximization of the affordances provided by the website during the design process. Participants also appreciated the presence of a wide range of information, both about local and non-local issues, highlighting the fact that such information is reliable and of good quality. This in the

end indicates that the website included a range of meaningful affordances to participants.

Finally, and probably one of the most significant findings from this section, the website presents some traits of what has been defined as a dynamic educational system (see Chapter 3): from an activity theory point of view, the website promoted *motivations* as outcomes, which in turn can become part of subsequent activity systems in what is known as expansive activity systems or expansive transformation, which can be the basis of a network of interacting and continuously developing activity systems, as in dynamic educational systems that, ideally, continuously nurture themselves.

From educational complexity theory, the website appears to be effective as an educational facilitator and leader, as it promoted access to a diversity of meaningful information and thinking around social engagement in sustainability, and was considered crucial by some participants to organize and take future actions regarding the sustainability of the lake.

6.4 Re-visits to the EfS website Lanalhue Sustentable

As part of the intervention, all 24 participants were invited to take part in the follow-up phase (i.e. phase 4d). In this phase, participants were contacted 5 months after their first use of the website, and were given a period of 5 weeks (i.e. follow-up period) to re-visit the EfS website. Note that participants were presented a slightly different version of the EfS website during the follow-up period, compared to the one from their first visit. Changes to the first version included the inclusion of new subsections that could not be included in the first version due to time constraints. However, changes suggested by participants presented in the previous section were not implemented in the EfS website for the follow-up period. This is principally due to time and resources contraints.

During the follow-up, participants were asked to regularly visit the EfS website based on their interest and motivation, and to keep either a mental or written record of their impressions and perceptions. At the end of the

follow-up period, participants were invited to answer an online questionnaire (i.e. follow-up survey) consisting of 9 questions (i.e. open-ended and closed questions).

The purpose of the questionnaire was to retrieve quantitative data regarding re-visits to the EfS website (i.e. number of visits, visit duration and sections visited), and to evaluate three key points related to participants' experience using the EfS website during the follow-up period: (1) participants' perceptions and opinions about the EfS website; (2) participants' learning and understanding process related to the use of the EfS website; and (3) participants' motivation to take action and to adopt sustainable living principles prompted by the EfS website. As in Section 6.3, the focus of this section is on the first aspect of the follow-up survey.

From the original 24 participants, 18 took part of the follow-up phase (i.e. the remaining six participants did not reply to the invitation to participate in this phase). In addition, five of the most committed participants were invited to be part of an intensive group, which had more regular contact with the researcher via email during the follow-up period. The main objective of having an intensive group was to gain input in regard to the third aspect of the follow-up questionnaire (i.e. participants' motivation to take action and to adopt sustainable living principles), and thus findings from this group are addressed in the coming chapters.

In this section findings from the follow-up survey are addressed. Firstly, Section 6.4.1 presents quantitative aspects of re-visits made to the EfS website by participants, and some qualitative insights in regard to the purpose of such re-visits. Secondly, findings related to participants' perceptions and opinions about the EfS website during the follow-up period follow in Section 6.4.2. Finally, Section 6.4.3 summarises key findings from this section.

6.4.1 Participants' re-visits to the EfS website

Quantitative data of re-visits to the EfS website during the follow-up period were obtained by means of the following closed question and sub-questions asked in the follow-up survey:

- Q1. Have you re-visited the lanalhuesustentable.cl website since your first visit?
- Q1c. How many times have you visited the website since the first time?
- Q1d. How long on average would you spend on the website each time you visited it?
- Q1e. Which sections of the website have you visited most?

The objective of these questions was to verify core information that could be provided by the Visits Overview and the Content Overview reports from Google Analytics (i.e. as in Section 6.3.1), this being the number of visits, average time per visit, and content visited. These metrics allow having a *visitor profile* for each follow-up participant, and to compare trends with results obtained from Google Analytics for visits made by participants during the intervention period (i.e. phase 4b). However, since the final version of the EfS website was officially released to the public one month before the start of the follow-up period (i.e. July 2011), assessment of these metrics using Google Analytics tools was impossible, as it was not possible to separate participants' visits from all other visits made to the EfS website by non-participant visitors.

6.4.1.1 Quantitative overview of participants' re-visits

Only one participant (i.e. Marcelo) provided a negative answer to Q1, signalling that he did not re-visit the EfS website at all during the follow-up period. The remaining 17 participants all indicated they re-visited the EfS website during the follow-up period. Table 6.13 presents the number of reported re-visits, and the average time spent on the website for each one of the 17 participants during the follow-up period. Almost half of the participants (i.e. n = 8) reported re-visiting the EfS website between 4 to 6 times; 6 participants did so between 1 to 3 times; Pamela and Ana re-

visited the website between 7 to 10 times; and Rafael did so more than 15 times during the 5 weeks of the follow-up period. In regard to the average time spent on the website, over 2/3 of participants reported they spent on average 15 or more minutes per visit on the EfS website (i.e. 11/16 participants); with Pamela, Ana and Emilio being the participants that spent most time (i.e. over 20 minutes) on average on the EfS website per visit.

Note that Pamela and Ana also are participants with a high number of visits to the website during the follow-up period (7-10 visits), indicating a high interest towards the EfS website; whereas Emilio only reported 1 to 3 revisits to the website during the follow-up period. In addition, Mario and Pablo are the participants with the lowest average time spent on the website per visit, and, Pablo as well is in the group of 6 participants reporting low number of visits to the EfS website during the follow-up period, with 1 to 3 visits, therefore being the participant that spent least time in total on the EfS website during the follow-up period.

Table 6.13. Number of reported re-visits and average time spent on the EfS website for each one of participants during the follow-up period (n = 17). Section codes are related to Figure 6.3.

Participant ID	Number of revisits (times)	Avg. time per visit (minutes)	Most visited sections (total)
Rafael	15 +	15	c,d,k,t (4)
Pamela	7 – 10	20 +	b,c,d,f,g,k,s,t,u (9)
Ana	7 – 10	20 +	b,c,d,e,s (5)
Doris	4 – 6	20	b,c,d,e,f,g,k,r,u (9)
Mario	4 – 6	5	b,c,d,u (4)
Romina	4 – 6	*	c,k,t (3)
Oscar	4 – 6	20	g (1)
Javiera	4 – 6	15	b,c,d,e,k,r,s,t (8)

Participant ID	Number of revisits (times)	Avg. time per visit (minutes)	Most visited sections (total)
Ramiro	4 – 6	20	f,g,r,s,t,u (6)
Javier	4 – 6	10	t (1)
Manuel	4 – 6	20	b,d,e,k (4)
Julia	1 – 3	15	b,c,d,e,f,t (6)
Maria	1 – 3	20	b,g,k,r,t (5)
Marisol	1 – 3	10	c,d,f,g,k,r,s,u (8)
Pablo	1 – 3	5	b,d,r (3)
Emilio	1 – 3	20 +	b,e,g,r,t (5)
Mateo	1 – 3	10	c,f (2)

* Romina did not indicate her average time spent on the website per visit.

Table 6.14 presents the most popular sections of the EfS website indicated by participants as the most visited during the follow-up period. Although this table aims to provide the same information as the Content Overview report from the intervention period (Section 6.3.1.2), here data regarding content visited is based on participants' reports on the online follow-up survey, in contrast to the Content Overview report from Section 6.3.1.2, which is based on quantitative data reported by Google Analytics.

The three sections of the EfS website indicated by participants as the ones most visited by them during the follow-up period are sections related to both local information and sustainability issues: the Lanalhue Lake, Sustainability and Luchecillo sections, all three pointed out 10 times by participants. In fourth to seventh place of most indicated sections come sections that include both local and non-local information, e.g. Mapuche Worldview section (i.e. top 4), and Articles section (i.e. top 7), respectively. From top 8 to top 11 are those sections that were the least indicated as the most visited, comprising the Solutions and Questions & Answers sections (i.e. both indicated 6 times), and the Local and Global

Experiences & Examples section plus the 'Links to Websites of interest' section, both indicated 5 times. The 'About this site' and the Credits & Acknowledgements sections were not indicated at all as visited sections, which evidently does not mean that participants did not visit them, but only that they were not reported as visited sections.

Table 6.14. Most and least visited sections of the EfS website reported by participants during the follow-up period (n = 17). Section codes are related to Figure 6.3.

EfS website section	N° of times indicated as most visited	Section code
1. Lanalhue Lake	10	b
2. Sustainability	10	c
3. Luchecillo	10	d
4. Mapuche Worldview	9	t
5. Video & Photos (Multimedia)	8	k
6. Documentation	7	g
7. Articles	7	r
8. Solutions	6	e
9. Questions & Answers	6	f
10. Local and Global Experiences & Examples	5	s
11. Links to Website of interest	5	u
12. About this site	0	w
13. Credits & Acknowledgements	0	v

In a general overview of data from Table 6.14, there is a slight tendency to a similar pattern when compared to results from the Content Overview report (i.e. from Google Analytics, phase 4b, see Table 6.7), this being a preference towards local issues. For example, in both cases the Lanalhue

Lake section (i.e. section b) and the Luchecillo section (i.e. section d) appear as part of the top group of the table; sections including more general topics are in the middle of the table; and sections considered secondary sections of the EfS website (i.e. see Table 6.6) are at the bottom of the table. Only four sections presented significant changes when compared to data from Table 6.7 (i.e. Content Overview report from Google Analytics). The Solutions and Questions & Answers (Q&A) sections presented a significant reduction of visits, from top 4 to top 8, and from top 1 to top 9, respectively. On the other hand, the Mapuche Worldview moved up from top 11 to top 4, and the Sustainability section moved up from top 6 to top 2. Note that this comparison between data from Table 6.14 and Table 6.7 only considers the 13 sections present in Table 6.14 (i.e. sections 'Social Networking links', Subscribe, and Participate & Collaborate from Table 6.7 were not included as part of the follow-up survey for being considered secondary sections of the EfS website, and thus not relevant for the main purpose of this study).

In a more detailed view of data from Table 6.14, it can be noted by looking at the total number of sections indicated by each participant as the most visited ones by them (i.e. far-right column in Table 6.14), that some participants indicated up to 9 sections as the most visited ones, and others in contrast only one or two. In the first case, Pamela and Doris (i.e. both indicating a total of 9 sections), and Javiera and Marisol (i.e. both indicating a total of 8 sections), are those participants that indicated a high number of sections. This could be interpreted that the website was highly meaningful to them in general.

On the other side, Oscar, Javier and Mateo only indicated 1 or 2 sections as the most visited ones (i.e. 1 for Oscar and Javier; 2 for Mateo), which may reflect the need to fulfil a particular interest (Brookfield, 1983; Thompson, 2002). For example, Javier indicated section (t) Mapuche Worldview as the section most visited by him (i.e. Javier visited the website between 4 to 6 times, on average for 10 minutes each time). In Section 6.3.2.2 Javier also highlighted the inclusion of the Mapuche

Worldview within the EfS website as something meaningful to him, stating in his post intervention interview that the inclusion and consideration of this cultural aspect was “a great decision” (Javier, post website use interview, *seq.* 216.01).

Nonetheless, as stated before, the above comparison is made linearly (i.e. considering data from both tables directly comparable), but such data come from two different methods of data collection: data from Table 6.7 was obtained using Google Analytics tools, whereas data from Table 6.14 was obtained by means of closed questions from the follow-up survey (self-reported data). Still, within the qualitative scope of the present study, such a comparison is considered valid, as what is being compared is the final result (i.e. number of visits) regarding the same thing (i.e. EfS website’s pages and/or sections), giving an indication of those pages or sections that were most attractive and/or more meaningful to participants as a cohort, and at the individual level, in the case of data from Table 6.14.

Coming back to Marcelo, who answered *No* to Q1 ‘have you revisited the lanalhuesustentable.cl website since your first visit?’, his answer directed him to question Q1a: Has anything prevented you from revisiting the website? To which he answered: “Not having in mind to visit the website. To prefer on my spare time to visit other sites, such as news, entertainment, email, Facebook, Flickr” (Marcelo, follow-up survey, *seq.* 421). And lately, as part of his last comment (i.e. answer to Q9 ‘space for a last comment’) of the follow-up survey, he stated: “Personally, I thought that I would visit the website more often, but it was not like that. And I regret to say that I only did it the first time” (Marcelo, follow-up survey, *seq.* 566.02).

Marcelo (i.e. as reported in Section 6.2.1) is one of the 6/24 participants who is not considered *historically* from the area, in this case from Cañete, where he reported to live during the intervention time (i.e. Cañete is the farthest place to Lanalhue Lake considered on this study), and reported having a *moderate* interest towards Lanalhue Lake. This could explain,

from an activity theory (AT) and community education point of view, the fact that re-visiting the EfS website may have been unattractive and/or meaningless to him: because Lanalhue Lake is not an integrative part of his socio-cultural background, as it was for many of the other participants. This finding supports theory highlighted at the end of Section 6.3.2.3, i.e. people pay attention to what is meaningful to them (Brookfield, 1986; Thompson, 2002), and in turn what appears to be meaningful to people, according to AT, is shaped by their socio-cultural background and role (Cole & Engeström, 2001; Yamagata-Lynch, 2007).

In summary, apart from Marcelo, participants did revisit the EfS website during the follow-up period (n = 17), and data related to quantitative aspects of the follow-up phase indicate that more than half of participants (n = 11/17) revisited the EfS website over four times, and 2/3 of participants spent over 15 minutes on the website on average per visit, indicating a good interest for the website over time overall. Yet, different participants showed different interests and concerns during their follow-up visits. Some of them had particular interests, like Javier who indicated only the Mapuche Worldview section as the most visited section by him, or Pamela and Doris who indicated up to 9 sections as those most visited by them.

6.4.1.2 Purpose of re-visits to the EfS website

In addition to quantitative data regarding re-visits to the EfS website, sub-question Q1b of the follow-up survey assessed qualitative aspects of participants' re-visits, asking 'for what purpose have you visited the website again?', with 15 participants providing answers. These answers were coded under four recurrent subthemes. Subtheme 'check new information (news, new posts)' (*theme code* 20.105) was the most recurrent one, with 8/15 participants scoring under it; followed by subtheme 'deeper review of information / multimedia' (*theme code* 20.110) as the second most recurrent subtheme, with 7/15 participants scoring under this category. The two other recurrent subthemes are 'check / apply information from the website (as reference)' (*theme code* 20.115), with

3/15 participants scoring, and ‘networking with local groups / other users’ (*theme code* 20.120), with 2/15 participants scoring. Table 6.15 presents these four recurrent subthemes, and the number of participants scoring under each one.

The three most recurrent subthemes regarding purposes to re-visit the website are all related to the concept of ‘information’, whether to check new or existing information, or to apply the information contained on the website. Two examples where participants indicated the purpose of checking new information are the ones provided by Pamela and Ana. Pamela said: “I have re-visited the website to check if there was any new information, and to further review the existing one” (Pamela, follow-up survey, *seq.* 428.01). Similarly, but with particular attention to the luchecillo and other sustainability experiences and examples, Ana said: “I have re-visited the website to check if there was any news regarding the luchecillo at the lake, and to check if there were any new articles regarding other sustainability experiences” (Ana, follow-up survey, *seq.* 429). Note that both Pamela and Ana reported a high number of re-visits, and a high average time spent on the website per visit, during the follow-up period (see Table 6.13), indicating interest and meaningfulness towards the EfS website by these two participants.

Table 6.15. Participants’ recurrent purposes of re-visits to the EfS website during the follow-up period (n = 15; *theme code* 20.10).

Subtheme	**N° of participants**
Check new information (news, new posts)	8
Deeper review of information / multimedia	7
Check / Apply information from the EfS website (as reference)	3
Networking with local groups / other users	2

Regarding participants’ purpose of achieving a deeper review of information already existing on the EfS website, Javier stated “I have

revisited the website with the objective of obtaining information regarding the Mapuche Worldview" (Javier, follow-up survey, *seq.* 436.01), this topic being his sole interest, according to data from Table 6.13. Another example is the one provided by Rafael, who was the participant who most re-visited the website (see Table 6.13): "I have re-visited it because the first time I checked it I was amazed by the amount and quality of information regarding a range of themes related to the Lanalhue Lake" (Rafael, follow-up survey, *seq.* 437.01). As indicated in Section 6.2, Rafael is not originally from the area, but had lived in Contulmo during the last years prior to the follow-up survey (i.e. Contulmo being the closest city to Lanalhue Lake considered for this study).

Concerning re-visits to apply the information present on the website, Romina was interested in re-visiting the website to retrieve information in order to set up some research units around the eutrophication of the lake issue with her science group at her school. As stated by her:

> [I re-visited the website] to carry out some monitoring and observations of the black-necked swans and the luchecillo; because people used to say that swans were responsible for the arrival and proliferation of the luchecillo...
>
> (Romina, follow-up survey, *seq.* 427)

Whereas Mateo, also a primary school teacher, reported that he applied the information on the EfS website for classroom purposes: "[I re-visited the website] to retrieve information that I can use and complement with the bioethics unit of my Philosophy class" (Mateo, follow-up survey, *seq.* 438).

Two important theoretical concepts must be noted in regard to the above data. First, the notion of participants re-visiting the EfS website with the objective of checking new information and/or achieving a deeper review of existing information, suggests a type of free-choice learning, which is characterized by being "self-directed, voluntary, and guided by individual needs and interests" (Falk & Dierking, 2003, p. 9). Second, from an activity theory point of view, to apply the information from the website can be seen as a type of action prompted by the EfS website, which can be viewed as

an expansive activity system, where the outcomes of an activity system can be used by other activity systems to reach other goals (Engeström, 2001; Krasny & Roth, 2010). This is similar to the argument related to the promotion of *motivations* regarded as a type of expansive system, in relation to the first interaction with the EfS website by participants during the intervention period (i.e. phase 4c; see Section 6.3.2.4).

In regard to the fourth and last recurrent subtheme related to purpose of revisits (i.e. excluding the ones related to the information present on the website), subtheme 'networking with local groups / other users' (*theme code* 20.120) is explicitly associated with the idea of using the EfS website for social networking; with Pamela and Ramiro being the 2 participants that scored under this category. Pamela reported that she wanted to check other local environmental groups and contact them (i.e. she is part of an environmental NGO, as reported earlier): "I also re-visited the website to get to know and contact other local groups or websites related to caring for the environment, and so be up to date with what is going on" (Pamela, follow-up survey, *seq.* 428.02).

Whereas, Ramiro simply stated that he wanted "to check the possibility of changing opinions and points of view with other website users" (Ramiro, follow-up survey, *seq.* 435.02). Note that theory highlights social networking and interaction as the basis of social learning (Guldberg, 2009; Krasny, 2010; Tilbury & Wortman, 2008; Webler et al., 1995), and that the EfS website, which includes the promotion of coupling and interaction between learning actors as one of its systems thinking fundaments for the creation and nurturing of educational systems (see Chapter 3 and Chapter 5), was able to provide the means (i.e. affordances) for participants to undertake social networking and interaction.

Overall, findings regarding the purpose of re-visits to the EfS website by participants indicate that the majority of re-visits were motivated by instances related to access and use of the information contained within, and provided by, the EfS website. As well, for two participants, the

objective of re-visits was to achieve social networking at the local level regarding environmental and sustainability issues. These findings suggest that, first, the website may have promoted learning by means of free-choice learning, as participants re-visited the website based on voluntary, self-directed, individual needs, which may have promoted *understanding* of sustainability issues; and second, from activity theory, the website promoted *actions* in the form of participants applying the information on the website (i.e. an outcome of the EfS website activity system) to achieve other goals.

6.4.2 Final perception of the EfS website

Participants' opinions and perceptions about the EfS website during the follow-up period were assessed principally by means of two questions (i.e. follow-up survey). Sub-question Q1b 'for what purpose have you visited the website again?', which initially was intended to evaluate participants' purpose of re-visits to the EfS website (i.e. as in Section 6.4.1.2), also prompted opinions from some participants regarding the website. And question Q9 'space for a last comment' provided participants the possibility to express any further comments, and the researcher to assess participants' final perception regarding the EfS website. Answers to these two questions were analysed using theme code 20.15 'opinion about the EfS website' for sub-question Q1b, and theme code 27.05 'last comment regarding the EfS website' for question Q9. In addition to these two questions, some answers from other questions of the follow-up survey provided by participants were also coded under the above two theme codes, and are part of the following analysis.

6.4.2.1 Opinion about the EfS website

Opinions about the EfS website *Lanalhue Sustentable* from the follow-up survey come mainly from answers to sub-question Q1b (Q1b was originally intended to assess participants' purposes of revisits to the website), provided by 8 participants. These and other opinions (prompted by other questions of the follow-up survey) were coded under four recurrent subthemes, with subtheme 'locally relevant (likes that)' (*theme*

code 20.155) being the most recurrent one with 5/8 participants scoring under it.

The second most recurrent subtheme, with 4/8 participants scoring, is the opinion that information on the website is 'complete (good, reliable, and including a wide range of information)' (*theme code* 20.170). The third most recurrent subtheme is 'website effectively assisted me (class preparation, information access, etc.)', with 3/8 participants scoring under it. Finally, the last recurrent subtheme, with only Ramiro scoring under it, is the opinion that the 'website is attractive ('calls' to re-visit)' (*theme code* 20.160). Table 6.16 below presents these four recurrent subthemes, indicating the number of participants scoring under each subtheme.

Table 6.16. Opinion about the EfS website (n = 8; *theme code* 20.15).

Subtheme	**N° of participants**
Locally relevant (likes that)	5
Complete (good, reliable, and including a wide range of information)	4
Website effectively assisted me (class preparation; information access; etc)	3
Attractive website, 'calls' to re-visit	1

The two most recurrent subthemes suggest high meaningfulness of the website to, at least, a group of participants. These subthemes suggest that the website is locally relevant (i.e. this being seen as something positive), and that the information contained on the website is complete, of good quality, broad, and reliable. Concerning the first point, three examples of answers where participants appreciated the website because of its local focus are the following:

- I think is excellent to have a website dedicated to disseminate the issues present in our ecosystem. (Marisol, follow-up survey, *seq.* 431)

- To me the website is very attractive because I know the lake and the local experiences shown on it very well. (Javiera, follow-up survey, *seq.* 432)
- Currently I live just by the lake, and that makes me be even more interested. (Rafael, follow-up survey, *seq.* 437.02)

It appears from these quotes that the website was significant and meaningful to these participants, which includes both long-term local participants (i.e. Marisol and Javiera) and recent local participants, like Rafael. It also appears that these three participants share in common that they know the lake very well and care about it, whether because they live close to it like Rafael, or because they have had a historical relationship with it, in the case of Marisol and Javiera.

Regarding the second point, that the information on the website is good and complete, which in turn makes it more meaningful to participants, Rafael stated:

> The luchecillo issue is something that worries me a lot, and although I heard many different opinions and theories about it from locals, in this website I found the most clear and complete information about it.
>
> (Rafael, follow-up survey, *seq.* 437.03)

These examples regarding the website being complete and locally relevant may be related to considerations from the theoretical model for the development of an EfS website that, according to the literature, are of assistance to make the message and content of the website relevant and meaningful at the local level. For example, from community education literature, the idea of understanding and addressing socio-cultural contexts and needs of the target audience (Brookfield, 1983; Dunn & Marinetti, 2008; Knight et al., 2009), and to include real-life and locally rooted issues (Nomura, 2004; Tilbury, 2008; Thompson, 2002).

Similarly, ICT literature also stresses the importance of clearly defining and addressing the target audience, in relation to ICT use and penetration

(Chu & Martinson, 2003), and the notion of addressing authentic and real-life issues (Nicolaou et al., 2009). Another ICT key consideration is to maximize all the affordances offered by the website, for which understanding of the local context, whether from a community education point of view or an ICT penetration point of view, becomes critical (Greenhow et al., 2009; Webb, 2005). Therefore, the integration of these theoretical ideas into the final EfS website appears to have successfully promoted meaningfulness and relevance among a group of participants, and particularly to participants that appear to have a close connection to the lake.

Concerning the third most recurrent subtheme, or the opinion that the website was effective in assisting participants' needs, like access to information, Javier (i.e. who has demonstrated so far an interest towards the Mapuche worldview), commented: "I have to say that this website successfully allowed me to better contextualize some topics, like for example the We Tripantu (Mapuche ceremony), and the local indigenous people's relationship with the lake" (Javier, follow-up survey, *seq.* 436.02). Similarly, Ramiro, who has an advanced knowledge regarding local environmental issues, said (i.e. while answering question Q5 dealing with attitude change towards the lake), that the website has been of great help to him:

> To say the truth, all these years my concern has been the problems and issues related to the lake. Today my attitude is still critical towards the passivity that authorities and the majority of inhabitants have towards the lake; but I have an interest for environmental issues, and your website has been of great help to me.
>
> (Ramiro, follow-up survey, *seq.* 505.01)

The fact that the EfS website assisted participants like Javier and Ramiro to fulfil their own personal needs, in these particular cases the need to access information and to use information as a reference, respectively, may be an indication of the occurrence of free-choice learning (i.e. characterized by being self-directed, voluntary, and to fulfil individual

needs) (Boyer & Roth, 2005; Falk & Dierking, 2002). Furthermore, such learning may be related to the promotion of understanding of sustainability issues related to the lake, as for Javier who explicitly indicated that he was able to better contextualize indigenous people's historical and cultural relationship towards the lake.

6.4.2.2 Final perception of the EfS website

Participants' final perception of the website was assessed by means of question Q9 'space for a last comment' of the follow-up survey. This question provided participants the possibility to express any last comments or to highlight any particular issue regarding the EfS website or the research project. Twelve participants provided answers to Q9, which were coded under seven recurrent subthemes.

The most recurrent subtheme was the perception that the website is "good for information access / learning point' (*theme code* 27.070), with 6/12 participants reporting so. Following recurrent subthemes such as 'good website / liked it' (*theme code* 27.055), 'good for classroom / educational purposes' (*theme code* 27.085), and 'contribution to local sustainability' (*theme code* 27.080), were recurrent perceptions with 3/12 participants scoring in each case. With 2/12 participants, then followed recurrent subtheme 'would be good to get news / info updates' (*theme code* 27.075). Finally, Maria found the website to be motivational, which was coded under subtheme 'motivational website' (*theme code* 27.060); and Mario reported as his last comment that he would "disseminate every possible day the existing issues at Lanalhue Lake" (Mario, follow-up survey, *seq.* 562), which was coded under subtheme 'motivation to disseminate lake's issues' (*theme code* 27.065).

Four key concepts linked to these final comments about the EfS website can be identified from participants' answers to question Q9. Firstly, the top three most recurrent subthemes can be related to affordances provided by the website. In particular, the perception that the website was meaningful to participants, whether for information access and as a learning point, or

just in overall aspects. One answer that highlighted the overall website design is the one provided by Rafael: “The website is really well designed, both aesthetically and in the clarity of its content” (Rafael, follow-up survey, *seq.* 575.01).

Whereas Javier and Marcelo (i.e. who was the sole participant that reported not revisiting the website during the follow-up period), commented on the educational potential of the website as a learning point. Javier even reported using the website for classroom purposes: “It’s a friendly website, in fact I was able to use it for an online class” (Javier, follow-up survey, *seq.* 574.02). And Marcelo highlighted the education potential of the website: “The website’s initiative is useful, it can assist students and people that are interested and want to learn about the lake” (Marcelo, follow-up survey, *seq.* 566.01).
In regard to the perception of the website being overall a good website, the last comment provided by Ramiro summarizes this quite nicely:

> I have reviewed with great interest every section of the website, and I have to say is by far the best have seen. Many people, institutions, and environmental groups have talked about the environmental problems of our region, but no one has been able to express all that in something so concrete as this website.
>
> (Ramiro, follow-up survey, *seq.* 584.02)

The above examples of answers from the top 3 most recurrent subthemes related to the idea that the website was overall a good website and a useful learning point indicate that the EfS website was meaningful for some participants. Meaningfulness of the website in turn indicates that the local, social and cultural characteristics and needs of the target audience were well assessed, addressed and integrated into the EfS website during the pre-design research phase (i.e. phases 1 & 2), and that website affordances were well maximized to meet local community characteristics and needs, providing relevance and meaningful information.

The second key concept to highlight from participants' last perceptions about the EfS website is the view that the website represents a contribution to local sustainability. One example of such a view is the answer provided by Javiera, where she even shows gratefulness towards the existence of the EfS website: "I like that there are persons worried about this fabulous lake, and that promote its conservation and sustainability. I think this website is a great contribution. Thanks for that" (Javiera, follow-up survey, *seq.* 570). The concept of the website being regarded as a contribution towards the local sustainability, actually represents one of the key goals of the EfS website, i.e. to promote sustainability, indicating, according to Javiera and the other 2 participants that were scored under this recurrent subtheme (i.e. Ana and Pablo), that the website is capable to play part in, and even lead, the process of bringing about socio-ecological sustainability in the Lanalhue Lake area.

The third concept to highlight from responses to Q9 is related to comments from Marcelo and Pamela about the possibility to provide news and information updates though the EfS website (*theme code* 27.075). This concept is important to highlight because within systems thinking, information flow and update is critical for systems resilience, as systems base their function, development and adaptation capacity on continuous information input, and interaction within system's components (Aracil, 1995; Capra, 1994; White, 2010). Hence, in the case of the EfS website taken as an educational system, information flow and update becomes a fundamental component to achieve a connected network (i.e. key to social learning), and a healthy system that can nurture itself over time (Jorg, 2000; Davis & Sumara, 2005). This information update issue was taken into consideration during the design and development of the EfS website, which does provide news and information updates through different means (i.e. Facebook, newsletter, and information update on the website).

The last key concept is the notion that the EfS website promoted motivations among some participants. As mentioned before, both Mario and Maria's answers were coded under this concept (i.e. *themes code*

27.065 & 27.060, respectively). Mario reported that he was motivated to disseminate the lake's issues (note that Mario reported the same in his last comment of the post-intervention interview, *seq.* 396.01, see Section 6.3.2.4), and Maria found the website to be motivational:

> I live just a few kilometres away from the lake, the ranges and the coast, and still there are many things and places that I don't know; *Lanalhue Sustentable* is a good website with pictures, local experiences and information that allowed me to acknowledge that we have a lot to do to conserve what we still have.
>
> (Maria, follow-up survey, *seq.* 564.01)

As at the end of Section 6.3, from an activity theory (AT) point of view, motivations are a critical component of activity systems, as they are related to an activity system's continuous development and expansive properties, as motivations as an outcome of one activity system can subsequently integrate other activity systems determining other goals, in an *expansive system* way (Krasny & Roth, 2010; Yamagata-Lynch, 2007). Thus the promotion of motivations gained from the EfS website, as for Mario and Maria, is something positive for the continuous development of the activity system determined by the EfS website, and actually those subsequent activity systems determined by such motivations, may end up in the promotion of taking action towards local socio-ecological sustainability.

6.4.3 Summary

Key points from Section 6.4 concerning re-visits to the EfS website during the follow-up period are the following. First, quantitative insights indicate that almost all participants of the follow-up period (i.e. n = 17/18) re-visited the EfS website, with more than half of these participants re-visiting the website over 4 to 6 times, and 2/3 of participants spending 15 or more minutes on average per visit. These figures indicate that, in general, participants were interested in the EfS website over time (i.e. during the follow-up period). As well, different participants reported different interests (i.e. based on their most visited sections), which is principally based on

participants' individual motivations and needs, like, for example, Javier who clearly indicated an interest towards the Mapuche Worldview section, or Oscar who reported to be more interested in the Documentation section.

Regarding the purpose of re-visits, the majority of participants were motivated to re-visit the EfS website in order to, either access information available on the website based on individual needs (i.e. check new information or achieve a deeper review of the existing information), which might be an indication of a type of free-choice learning as highlighted earlier; or to apply the information contained on the website to carry out targeted actions based on the website's information, like Romina and Mateo who applied the information for educational purposes at their schools. From an activity theory perspective, to apply information from the website to carry out other activities and/or actions indicates evidence of *expansive transformation* of the activity system based on the website as a tool, as such an activity system prompted outcomes that subsequently integrated other consecutive and related activity systems (i.e. similar to what was reported in Section 6.3). Furthermore, promotion of subsequent motivated actions, like in the case of Romina who wanted to design and set up some research units around the eutrophication of the lake issue based on the information from the EfS website, can be evidence of taking *action* prompted by the website.

A third purpose to re-visit the EfS website was the one indicated by 2 participants, i.e. Pamela and Ramiro, who explicitly indicated that they revisited the EfS website with the purpose of achieving social networking. This is a key finding as social networking and interaction, through mechanisms to prompt ideas to interact like the EfS website acting as an integrator or facilitator, are believed to promote social learning (Tilbury & Wortman, 2008; Jorg, 2000; Sumara & Davis, 1997), in this case, around sustainability issues present at Lanalhue Lake. As well, a communicative and connected network, highlighted as another quality of dynamic

educational systems in Section 6.3.3, is a critical process in complex systems for the promotion of learning.

In regard to participants' opinions and final perceptions about the EfS website, the overall feeling is that the website was highly meaningful to participants in general, by providing reliable, complete and relevant information in a motivational and attractive way, and by being a learning point at the local level. Another opinion from participants is that the website effectively assisted some participants to fulfil their own individual needs, like Ramiro who was able to access information on the website that has been of assistance to him, or Javier who was able to use the information on the website as a reference to better contextualize the Mapuche Worldview at the local level. This, again, may be an indication of the occurrence of free-choice learning based on the EfS website. Finally, the EfS website appeared to act as an educational leader, by providing instances not only for information access and flow (i.e. even to fulfil participants' individual needs in some cases), but also for social interaction, interactivity and networking, which is said to underlie learning processes in complex systems (Jorg, 2000; Davis & Sumara, 2005; Morrison, 2002).

6.5 Summary

Demographic and profile data from the pre-intervention questionnaire indicated that the 24 participants of this intervention, as a cohort, were mainly *historically* local community members, with a few participants considered as *new* community members (e.g. participants living in the area for less than a year at the time of the intervention). Regarding participants' *interest* towards Lanalhue Lake environmental and sustainability issues, most of them reported a high interest. Despite this general interest towards the lake, 2/3 of participants declared poor *knowledge* regarding Lanalhue Lake's issues. On the side of ICT literacy, almost all participants declared to have good Internet access, and a good or very good Internet literacy. In terms of use of environmental and/or sustainability websites, all of participants declared having visited at some

point a website of such characteristics, with 9/24 reporting a frequent use of such websites (i.e. prior to their use of the EfS website lanalhuesustentable.cl).

Findings from the post-intervention interviews regarding *how* participants use an EfS website indicate that, as a cohort, they presented a tendency to visit sections related to local sustainability issues, in particular sections addressing the main topic of the website, i.e. the eutrophication process of the lake. Nonetheless, other more general sections addressing non-local sustainability issues, for example, and sections related to ICT and Web 2.0 affordances, such as the multimedia sections or the social networking sections, also showed good interest from participants.

Regarding use over time, findings from the follow-up survey show that, with the majority of participants re-visiting the website many times during the follow-up period, there is still a tendency to visit locally-related sustainability issues sections and information. However, that tendency is not as clear as for their first visit (i.e. intervention phase 4b), with more general information sections showing a bit more interest from participants. What is clear though is that different participants showed different interests during their re-visits to the EfS website, based on different motivations and needs.

In regard to *what* participants used the EfS website *for*, findings from the follow-up period indicate that participants re-visited the website for 3 main purposes: firstly, to access information, i.e. whether new information on the website or to carry out a deeper review of existing information, a situation that presents some evidence of free-choice learning, as some participants accessed the website targeting particular information, in a self-directed and voluntary way, and depending on individual needs, with evidence of learning and understanding in some particular cases.

The second main purpose to re-visit the website was, for some participants, to apply its information in planned activities and actions, in

some cases actions related to the sustainability of the lake, as with Romina and her research project to study the luchecillo with the school science group she leads. From an activity theory perspective, this and other cases indicate *expansive transformation* of the activity system based on the EfS website as a mediating tool. And the third purpose to revisit the website, as reported by 2 participants, was to achieve social networking with other EfS websites users, or with the EfS website's own network of partners and collaborators. This promotion of social networking facilitated by the EfS website is a key concept within this study, as the EfS website was designed with the consideration of being a social networking facilitator, which is believed in the literature as the basis of social learning, and a key characteristic of dynamic educational systems.

In addition, findings from both the post-intervention interviews and the follow-up survey regarding participants' *perceptions* of the EfS website indicate that the website was meaningful to the great majority of them. Participants highlighted the EfS website's qualities such as relevance, attractiveness, clarity, accessibility, graphical design quality, and reliability of the information contained on it. As well, participants appreciated the incorporation of a complete and wide range of local and non-local information related to socio-ecological sustainability, and even some of them found the website to be motivational and a good learning point.

These findings indicate that the EfS website was able to provide a wide range of meaningful affordances, meaning that considerations regarding these issues were effective during the website design and development, as some objectives of the website, principally related to ICT and website affordances design objectives, have been accomplished. This indicates the capacity of the website to promote *understanding* and *action*, addressed in the coming two chapters.

Finally, and in consideration of a key objective from the theoretical model for the design EfS websites, i.e. which is to design EfS websites that are capable to act as an EfS leader and facilitator in a dynamically self-

nurturing way, findings from both the post-intervention interviews and the follow-up survey indicate that the EfS website lanalhuesustentable.cl presented some characteristics of what complexity theory in education literature highlights as evidence of a dynamic educational system: from an activity theory perspective, the website promoted *motivations* as outcomes, which can become then part of subsequent and interrelated activity systems, in an expansive transformation way, which in turn is at the basis of a network of interacting activity systems.

From complexity theory in education perspecive, promotion of interactivity within an educational system is a key condition to self-nurture such an educational system, and is a key component to create a collective learning system, this being the ultimate goal of an educational system, according to some authors. Another characteristic of a dynamic educational system seen to be present on the EfS website is its capacity to act as an EfS facilitator or leader, meaning to promote information access and flow, social interaction and networking, and social learning towards sustainability. Other characteristics still to be seen on the website are its capacity to promote learning and empower social transformation towards sustainability. The coming two chapters shed some light on this matter.

CHAPTER 7 - UNDERSTANDING OF SUSTAINABILITY ISSUES AT LANALHUE LAKE

7.1 Introduction

In this chapter, whether the EfS website promoted and improved participants' understanding regarding socio-ecological sustainability issues present at Lanalhue Lake is evaluated. This is done by assessing change in understanding between participants' pre-intervention levels of understanding and knowledge, and reported learning and change in understanding after their first visit to the EfS website (i.e. post-intervention interview), and over time (i.e. follow-up phase). In order to achieve this, in Section 7.2 three different typology groups regarding pre-intervention levels of understanding are defined, based on both findings from a series of questions dealing with participants' reported levels of awareness, knowledge, understanding and/or ecological literacy; and on guidelines from an *ecological literacy framework* presented in the first part of the section.

Based on the distribution and categorization of participants into these three different typology groups related to levels of understanding, in Section 7.3 data from the post-intervention interview related to participants' learning, motivation, and understanding change of sustainability issues at Lanalhue Lake, after participants' *first visit* to the EfS website, is evaluated. Finally, in Section 7.4 the same evaluation process regarding change in understanding of sustainability issues at Lanalhue Lake is made, but *over time*, i.e. based on participants re-visits to the EfS website during the follow-up period.

Findings from this chapter will determine whether or not the EfS website was able to promote and improve participants' levels of understanding of socio-ecological sustainability issues present at Lanalhue Lake; and, in the positive cases, to determine what kind of change in understanding the website promoted for individual participants, and for the typology groups. This directly addresses this study's research question regarding the ability

of EfS websites to improve understanding of sustainability issues at the community level, in the context of the Lanalhue Lake in Chile.

7.2 Participants' pre-intervention understanding of sustainability issues present at Lanalhue Lake

This section addresses findings from the pre-intervention questionnaire (i.e. phase 4a), regarding participants' level of understanding of sustainability issues present at Lanalhue Lake, prior to their use of the EfS website. The first part of the section presents environmental and sustainability issues occurring at Lanalhue Lake that were identified by participants. The second part presents participants' views regarding the causes of those sustainability issues, and the source of information upon which they base their understanding.

Then follows Section 7.2.3, where data from the previous two sections, and some data from the participants' profiles section of the previous chapter (Section 6.2), are combined to categorise participants into different typology groups in relation to their level of understanding of sustainability issues present at Lanalhue Lake. This is done in order to examine and compare participants' apparent change in understanding regarding sustainability issues at Lanalhue Lake after their first use of the EfS website (i.e. Section 7.3), and participants' apparent change in understanding *over time*, based on data from the follow-up phase (i.e. Section 7.4).

In order to categorise participants into different typology groups related to their understanding of sustainability issues at Lanalhue Lake, criteria from the following *ecological literacy framework* have been taken into consideration. The two main EfS concepts underpinning this framework are *systems thinking* and *ecological literacy*. As reviewed in Chapter 2, scholars in the field of EfS stress that these two concepts are crucial to understand the complexity of sustainability issues, and together, with other key concepts e.g. *action competence*, form the basis of a literate person in a sustainable society (Armstrong, 2005; Barlow & Stone, 2005; Capra,

2005; Huckle, 1993; Orr, 2004; Sterling, 2001; Tilbury & Wortman, 2008). In this view, *systems thinking* implies the capacity to understand complex and unpredictable systems, e.g. such as socio-ecological systems, with attention to patterns, connections, and root causes (Huckle & Sterling, 1996; Orr, 2004; Sterling, 2001; WWF, 2005).

On the other hand, as pointed out by Capra (2005), *ecological literacy* involves the understanding of fundamental principles and patterns of organization of organic systems, i.e. ecosystems; or in the words of David Orr, it implies "a broad understanding of how people and societies relate to each other and to natural systems, and how they might do so sustainably" (Orr, 1992, p. 92). Considering the above, the *ecological literacy framework* used in this section defines typology groups of understanding of sustainability issues at Lanalhue Lake as follows:

- *Group 1 (G1) - High level of understanding:* Participants placed in this group showed an indication of a *good-to-advanced* level of systems thinking and ecological literacy in regard to identifying the *big picture* and the underlying causes of sustainability issues at Lanalhue Lake; and based their knowledge on reliable sources of information, e.g. experts or direct experiences. In general, they present a *deep understanding* of sustainability issues.

- *Group 2 (G2) - Medium level of understanding:* Participants in this group presented a *fair-to-good* level of understanding of issues at Lanalhue Lake, without evident indication of systems thinking and/or ecological literacy. They could identify common knowledge (i.e. at local level) sustainability issues and the involved stakeholders; their knowledge was mainly based on mainstream sources of information like word-of-mouth and local media. In general, participants within this group presented an *average understanding* of sustainability issues.

- *Group 3 (G3) - Low level of understanding:* Participants in this group presented a *none-to-poor* level of understanding of

sustainability issues at Lanalhue Lake. They showed no indication of systems thinking and/or ecological literacy at all, and could only identify common knowledge and/or local myths (i.e. alternative conceptions) regarding sustainability issues at Lanalhue Lake. They based their knowledge on word-of-mouth and/or local media. In general, participants in this group presented a *poor* or *substandard understanding* of sustainability issues.

These three typology groups make it possible to categorise participants' answers presented in the coming two subsections into different levels of understanding of sustainability issues at Lanalhue Lake, and to categorise participants themselves into one of the typology groups later in Section 7.2.3.

7.2.1 Participants' identification of existing sustainability issues

Participants' pre-intervention awareness and understanding of Lanalhue Lake's sustainability issues were indicated by their answer to the following question from the pre-intervention questionnaire:

- Q12. Please identify any environmental/sustainability issue(s) at Lanalhue Lake that you know of (list up to 3).

All 24 participants provided answers to question Q12:

- 4/24 participants indicated the presence of one issue;
- 6/24 participants indicated the presence of two issues;
- 14/24 participants indicated the presence of three existing environmental and/or sustainability issues at Lanalhue Lake.

Data from answers to question Q12 were analysed using *theme code* 8.00 'Lanalhue system issues pre-awareness / understanding' of the Codebook, and coded under six level-2 subthemes. Table 7.1 presents these recurrent subthemes indicating the number of participants scoring under each one. Note that all the issues reported in Table 7.1 are related to sustainability issues existing at Lanalhue Lake.

Table 7.1. Participants' main level-2 subthemes of identified sustainability issues present at Lanalhue Lake (n = 24, *theme code* 8.00; participants could list up to 3 issues, total reported issues = 57).

Subtheme	N° of participants
Pollution of Lanalhue Lake	21
Eutrophication of Lanalhue Lake	16
Other ecological issues in the area	6
Lack of environmental care	3
Overpopulation of Lanalhue Lake's shores	2
Lack of ecological leadership	1

The concept of *pollution* of the lake, or the view that the waters of the lake are polluted, was the most commonly indicated sustainability issue by participants, with 21/24 participants doing so. From these answers:

- 13/21 participants indicated pollution from *sewage waters* from Contulmo and close-by houses (*theme code* 8.155);
- 7/21 participants reported a *general pollution* of the lake, principally from rubbish littering (*theme code* 8.15);
- 6/21 participants indicated water pollution from the presence of motorboats (*theme code* 8.160);
- 3/21 participants attributed the pollution of the lake to the arrival of black-necked swans during the year 2003-04 (*theme code* 8.165; see Section 5.2.1)

The participants' second most reported sustainability issue present at Lanalhue Lake was the process of *eutrophication* of the lake, with 16/24 of participants indicating this issue. Data coded under this category generally included answers such as 'presence/growth of luchecillo / *Egeria densa*' or 'eutrophication of the lake'. The two main categories of identified sustainability issues, *pollution* and *eutrophication* of the lake, indicated by a total of 23/24 participants (i.e. excepting Mario), and including 45 of the

total 57 reported sustainability issues present at Lanalhue Lake, are here considered as a *medium* (Group 2) level of knowledge/understanding regarding sustainability issues present. Note that these two sustainability issues were also the two most reported sustainability issues by local community members in survey 2b 'assessing existing conceptions related to the sustainability of Lanalhue Lake', which was part of the pre-design research phase of this study (i.e. phase II, see Section 5.3.2). The other four recurrent issues reported by participants, as in Table 7.1, were:

- 'Other ecological issues' (i.e. including answers such as *decrease of local biodiversity*, or *negative impacts from forestry industry*, n = 6/24);
- 'Lack of environmental care' (n = 3/24);
- 'Overpopulation of Lanalhue Lake's shores' (n = 2/24);
- 'Lack of ecological leadership' (n = 1/24, i.e. Mario).

These four categories of answers to Q12, in contrast to the two most recurrent ones presented above, are considered as a more *advanced* (Group 1) type of knowledge/understanding regarding sustainability issues present at Lanalhue Lake, as they involve a *deeper* understanding and some degree of systems thinking and/or ecological literacy, e.g. to be able to holistically relate different issues as part of the same ecological problem. Two participants who showed this type of understanding in relation to the sustainability of the lake were Ramiro and Mario. Ramiro, a secondary teacher from Contulmo with an advanced knowledge of the issues at Lanalhue Lake, related the eutrophication process to the uncontrolled increase of households and camping areas around the shores of the lake, and with changes in the water temperature, and the decrease of local fish populations. The three issues he reported were:

1. Eutrophication of the lake;
2. Uncontrolled increase of camping areas and holiday cottages (sewage water and rubbish problem);
3. Increase of the water temperature and loss of fish.

(Ramiro, pre-intervention questionnaire, *seq.* 42)

In contrast, Mario, who is from Cañete, reported a high interest and good knowledge of sustainability issues at Lanalhue Lake, and worked at one of the local councils at the time of the intervention. He highlighted the role of the Chilean environmental legislation and regulations, the lack of environmental care, and the lack of ecological leadership at the local level:

1. The deficient regulations and laws regarding environmental issues
2. Overpopulation of lake's shores without preventive measures and environmental care
3. The lack of leaders that generate clear policies for a good coexistence of lake's users and stakeholders

(Mario, pre-intervention questionnaire, *seq.* 28)

In summary, all participants were able to identify either environmental or sustainability issues present at Lanalhue Lake, with most participants showing at least a *medium* (Group 2) type of understanding of the sustainability issues present at the lake.

7.2.2 Participants' reported causes of sustainability issues

In regard to participants' pre-intervention views and perceptions of the *cause* of environmental and sustainability issues present at Lanalhue Lake, and the source of information on which they base such views, these were assessed by means of the following questions from the pre-intervention:

- Q12a. How have you learnt about this/these environmental/sustainability issues at Lanalhue Lake?
- Q12b. What do you think has caused these issues?

7.2.2.1 Sources of participants' understanding of sustainability issues

All participants answered question Q12a dealing with their sources of information regarding sustainability issues at Lanalhue Lake. Note that participants were able to indicate more than one source of information as an answer to question Q12a, resulting in a total of 36 answers coded into three main categories of level-2 subthemes, and six recurrent level-3 subthemes, using theme code 9.00 'sources of information about issues at

Lanalhue Lake' of the Codebook. Table 7.2 presents these recurrent subthemes, indicating the number of participants scoring under each one, and the total number of mentions for each level-2 category of sources of information.

Table 7.2. Participants' reported sources of information regarding sustainability issues present at Lanalhue Lake (n = 24, *theme code* 9.00).

Subtheme (Level 2 & 3)	**Totals ***	
	L3	**L2**
9.05 Personal perception / direct experience	2	**21**
Direct experience with sustainability issues	15	
Word of mouth at local level	9	
Work-related experience	1	
9.10 News / Media	6	**8**
Radio	1	
Internet	1	
9.15 Experts	0	**1**
Local environmental group	1	

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

Data from Table 7.2 indicates that the majority of participants (n = 21/24) base their understanding of sustainability issues at Lanalhue Lake on what has been defined as the 'personal perceptions / direct experiences' category. Under this category, subtheme 'direct experience with sustainability issues' (*theme code* 9.060), in which 15/24 participants scored, was the most recurrent source of information on which participants based their understanding of sustainability issues at the lake; followed by subtheme 'word of mouth at local level' (*theme code* 9.055), with 9/24

participants scoring under it. In third place of most indicated sources of information was the 'news / media' category (*theme code* 9.10), representing one third (n = 8/24) of participants. This category included sources of information such as newspapers, radio and TV. Note that Pamela, the youngest participant of the cohort, was the only participant to explicitly indicate the 'Internet' (*theme code* 9.110) as a source of information regarding sustainability issues at Lanalhue Lake.

On the other hand, Ramiro's answer to question Q12a was the only one coded under the 'experts' category, in particular under subtheme 'local environmental group' (*theme code* 9.160). Ramiro's answer suggests a high level of understanding of environmental and sustainability issues at Lanalhue Lake, as he has been actively involved with local environmental groups that work towards the care of the lake. In his own words: "Well for many years now I have been participating in environmental groups that have strived to reduce the problems without much results" (Ramiro, pre-intervention questionnaire, *seq.* 67.01).

Other subthemes that also may indicate a more *advanced* (Group 1) understanding of sustainability issues are subtheme 'direct experience with sustainability issues' (n = 15/24 participants), and subtheme 'work-related experience'. These sources of information involve some sort of practical knowledge, and probably in some cases like Rafael who lives just by the lake, some degree of affective response towards existing sustainability issues at the lake, enhancing the possibility of a more advanced overall understanding of those sustainability issues, compared to participants who do not have such direct experiences. This may be because, as in the literature, immediate and locally rooted issues tend to be more relevant and meaningful to people (Brookfield, 1986; Thompson, 2002; Tilbury & Wortman, 2008).

7.2.2.2 Participants' views of the cause(s) of sustainability issues at Lanalhue Lake

All participants answered question Q12b 'what do you think has caused these [sustainability] issues?'. Answers indicate the following:

- 11/24 participants identified one cause;
- 7/24 participants identified two causes;
- 4/24 participants identified three causes;
- 1/24 participant (i.e. Ernesto) identified up to four causes.

In total 41 *causes* of sustainability issues were reported by 23 participants, with five main level-2 recurrent subthemes identified, and coded using theme code 10.00 'cause of issues at Lanalhue Lake' of the Codebook. Table 7.3 below presents these five main recurrent subthemes, and the number of participants scoring under each one.

Table 7.3. Participants' recurrent views of the causes of sustainability issues at Lanalhue Lake (n = 23, *theme code* 10.00; total issues mentioned = 41).

Subtheme	**N° of participants**
Lack of environmental care / awareness / knowledge	16
Anthropogenic origin	11
Diversity of factors	6
Natural origin	5
Lack of (environmental) education	3

One participant, Soledad, was the only participant who did not identify possible causes and responded to question Q12b: "I could not say what are the motives [that have caused sustainability issues]" (Soledad, pre-intervention questionnaire, *seq.* 95). This possibly indicates a *low* (Group 3) level of understanding regarding the sustainability issues at Lanalhue Lake.

The most recurrent *causes* of sustainability issues at Lanalhue Lake, identified by 16/23 participants, were that sustainability issues have originated due to a general 'lack of environmental care / awareness / knowledge' (*theme code* 10.10), with respondents placing the responsibility at different levels, i.e. national and local authorities, local community members, stakeholders and lake visitors.

This view, added to the view reported by 3/23 participants specifying that the cause of sustainability issues at the lake was due to a 'lack of education' (*theme code* 10.15), or of a "lack of environmental education" as pointed out by Emilio (pre-intervention questionnaire, *seq.* 90.02), are taken here as an indication of a *medium* (Group 2) level of understanding of sustainability issues at Lanalhue Lake, as participants scoring under these two recurrent subthemes focussed on cultural causes of sustainability issues, but without some degree of systems thinking and/or ecological literacy.

In contrast, the second and third most recurrent main level-2 subthemes from Table 7.3, i.e. the views that the cause of sustainability issues at Lanalhue Lake are issues related to 'anthropogenic origin' (*theme code* 10.20; indicated by 11/23 participants), and to a 'diversity of factors' (*theme code* 10.05; indicated by 6/23 participants), plus the view indicated by Ernesto, "the lack of native forests" (Ernesto, pre-intervention questionnaire, *seq.* 99.03; *theme code* 10.260), indicate on the other hand a more *advanced* (Group 1) understanding of the sustainability issues at Lanalhue Lake.

These answers involve some degree of systems thinking and ecological literacy from participants, like the capacity to interrelate different factors as the *cause* of sustainability issues. For example, Ernesto's view above that links the ecological quality of the lake with the quality of its surrounding forests; or Ramiro who highlighted a range of factors of anthropogenic origin as being at the *cause* of sustainability issues: "the deforestation of the catchment; the progressive increase of human activity; [and] the

dumping without much control of sewage waters from the city of Contulmo into the lake" (Ramiro, pre-intervention questionnaire, *seq.* 92).

Similarly, Manuel also pointed to factors related to anthropogenic activity, but with attention to the intensive forestry industry present in the region, and showing a very good understanding of the effect of such industry on the sustainability of the lake:

> The sedimentation, rich in nitrogen and phosphorus, which has been produced by the accelerated development of the forestry industry in the area, during winter is carried into the lake through tributary streams and/or rains, carrying all the residues from that activity to the lake.
>
> (Manuel, pre-intervention questionnaire, *seq.* 100.01)

Finally, four participants (i.e. Marcelo, Marisol, Javier and Mariana) indicated that a *cause* of a sustainability issue present at Lanalhue Lake such as the introduction and proliferation of the invasive aquatic plant *Egeria densa* or 'luchecillo', was the 'arrival of black-necked swans' in large numbers during late 2003 - early 2004 (*theme code* 10.255).

As mentioned earlier (see Section 5.2.1), the view that black-necked swans are the sole cause of the introduction and proliferation of the luchecillo into the lake is considered in this study as being a strongly-rooted local myth, and an alternative and simplified conception of the *real causes* that induced the accelerated eutrophication of the lake, which evidence suggests are the sum of a range of different factors (i.e. factors from anthropogenic origin, natural processes, cultural processes, political processes, etc.).

Hence, answers from these four participants pointing to black-necked swans as the *cause* of the eutrophication of Lanalhue Lake are considered to involve a *low* (Group 3) understanding of sustainability issues present at Lanalhue Lake, when compared with the other recurrent subthemes from

Table 7.3, and based on criteria from the *ecological literature framework* presented earlier in this section.

7.2.3 Participants' pre-intervention level of understanding of sustainability issues

By combining findings from data related to levels of awareness, knowledge, understanding and/or ecological literacy reported and/or manifested by participants in relation to the sustainability issues present at Lanalhue Lake, and based on the *ecological literacy framework* presented earlier, it was possible to categorize participants into three different groups, or typologies, related to their pre-intervention understanding level of sustainability issues at Lanalhue Lake.

The following *scoring system* has been followed as a guideline to categorise participants into typology groups: participants' answers to questions Q11, Q12, Q12a and Q12b of the pre-intervention questionnaire were scored as either *high* (H), *medium* (M), or *low* (L), based on the *ecological literacy framework* presented earlier. For each (H) answer 3 points were given; for each (M) answer 1 point was given; and for each (L) answer no points were given. This guide to score participants' answers allowed a larger distribution of scores by favouring (H) answers and not favouring (L) answers, thus helping the definition of boundaries between the three groups. Table 7.4 presents these typology groups, showing the type of answer each participant reported, and in which group each participant falls.

Table 7.4 indicates that Group 1, including those participants that overall showed a *high* understanding of sustainability issues at Lanalhue Lake, comprises 7/24 participants; Group 2, including those participants that showed a *medium* level of understanding, is composed of 8/24 participants; and Group 3, which includes participants that overall demonstrated a *low* level of understanding over sustainability issues, includes 9/24 participants. Alternatively, boundaries could had been set considering equivalent score segments (i.e. 1-4, 5-8, 9-12), giving a

different distribution of participants within typology groups (i.e. 4 participants in Group 1, 11 participants in Group 2, and 9 participants in Group 3). Nonetheless, boundaries between typology groups were set as in Table 7.4 with the aim of having a more or less similar number of participants in each group, permitting a simpler comparison between typology groups regarding change in understanding, at the group level.

Table 7.4. Typologies of participants regarding their pre-intervention level of understanding of the sustainability issues present at Lanalhue Lake. Scoring is based on the *ecological literacy framework* (n = 24).

Participant	**Q11. Reported know-ledge**	**Q12. ID of sustaina-bility issues**	**Q12a. Source of infor-mation**	**Q12b. Cause of sustaina-bility issues**	**Group (n)**
Romina	H	H	H	H	**1** (7) Score ≥ 8
Ramiro	M	H	H	H	
Ernesto	M	H	H	H	
Doris	M	H	H	H	
Pamela	M	M	H	H	
Rafael	M	M	H	H	
Manuel	M	M	H	H	
Benjamin	L	M	H	H	**2** (8) Score = 5-7
Pablo	L	H	H	M	
Mario	M	H	M	M	
Mateo	L	M	H	M	
Emilio	L	M	H	M	
Javiera	L	M	H	M	
Nora	L	M	M	H	
Julia	L	H	M	M	

Participant	Q11. Reported know-ledge	Q12. ID of sustaina-bility issues	Q12a. Source of infor-mation	Q12b. Cause of sustaina-bility issues	Group (n)
Javier	L	M	H	L	**3** (9) Score ≤ 4
Mariana	L	M	H	L	
Soledad	L	M	H	L	
Ana	L	M	M	M	
Oscar	L	M	M	M	
Rosario	L	M	M	M	
Maria	L	M	M	M	
Marisol	L	M	M	L	
Marcelo	L	M	M	L	

Codes: (H) = *high*; (M) = *medium*; (L) = *low*, in regard to the type of answer to questions Q11 to Q12b.

7.2.4 Summary

Data from the pre-intervention questionnaire presented in this section regarding participants' reported levels of awareness, knowledge, understanding and/or ecological literacy over Lanalhue Lake's sustainability issues, as well as participants' views of the causes of such issues and the sources of information on which they based such views, allowed the categorization of participants into three different typology groups. These typology groups are referred to participants' pre-intervention levels of understanding of sustainability issues at Lanalhue Lake, and are underpinned by guidelines from the *ecological literacy framework* presented earlier, where indication and/or presence of *systems thinking* and/or of *ecological literacy* within participants' answers were the principal feature evaluated.

This division of participants into typology groups regarding their level of understanding provides the basis to assess and compare levels of *change in understanding* between participants, and between typology groups, based on participants' visits to the EfS website during the intervention phase (i.e. phase 4b), and based on re-visits to the website during the follow-up phase (i.e. phase 4d). Findings regarding participants' *change in understanding* based on the EfS website *Lanalhue Sustentable* now follow.

7.3 Change in understanding after the first visit to the EfS website lanalhuesustentable.cl

This section presents findings from the post-intervention interview phase (i.e. phase 4c), in regard to participants' change in understanding in relation to sustainability issues present at Lanalhue Lake, after their first visit to the EfS website. Three questions from the post-intervention interview aimed to assess participants' change in understanding related to their visits to the EfS website:

- Q4. Did you learn something new after visiting the website?
- Q4a. Has your level of understanding of the environmental and sustainability issues at Lanalhue Lake changed or improved?
- Q4b. Based on your visit to the website, do you have a new interest or concern towards the sustainability of the lake?

The first question aimed to explore if participants felt that they learned *anything* from the website, whether related to local sustainability issues or not; whereas question Q4a specifically addressed participants' self-perceived change in understanding regarding *Lanalhue Lake's* environmental and sustainability issues. The third question (i.e. question Q4b) sought to assess participants' level of interest towards Lanalhue Lake, after their first visit to the EfS website. Answers from these three questions were analyzed and coded using theme code 16.00 'participants' learning / understanding change from use of the website' of the Codebook. Note that, in some cases, not all participants were asked the two last questions, principally due to participants' time availability, and to the

intervention's logistics. As well, answers to questions Q4 and Q4a prompted very similar findings. Hence, in consideration that the process of *learning* also involves a *change in understanding* (in regard to sustainability issues at Lanalhue Lake), and that the majority of participants' answers in both cases were related to Lanalhue Lake, data from these two questions were combined and are presented together.

In the coming sections, findings from these three questions are presented, highlighting overall results in relation to the three typology groups defined in Section 7.2.3 regarding participants' level of understanding of sustainability issues at Lanalhue Lake (see Table 7.4).

7.3.1 Participants' reported learning and change in understanding after the first visit to the EfS website

All 24 participants were asked and gave feedback to question Q4 'did you learn something new after visiting the website?'. Regarding question Q4a 'has your level of understanding of the environmental and sustainability issues at Lanalhue Lake changed or improved?', 21/24 participants provided answers. Both set of answers from participants were analysed using theme code 16.00 'participants' learning / understanding change from use of the EfS website' of the Codebook, and grouped into four main level-2 recurrent subthemes. Table 7.5 below presents this data, indicating the number of participants from each typology group scoring under level-2 and/or level-3 subthemes.

Data from questions Q4 and Q4a indicate that all 24 participants scored under level-2 subtheme 'learning / improved understanding' (*theme code* 16.05), the most recurrent level-2 subtheme. This means that all participants (including participants from all three typology groups) felt they did learn something new about sustainability issues at Lanalhue Lake, including a *change in understanding*, based on their experience visiting the EfS website. This reinforces previous findings (see Section 6.4.2) regarding theoretical considerations of the need to reach the broader audience of the target community by including a variety of information in

terms of depth and sophistication (Brookfield, 1990; Dohn, 2009; Menzel & Bögeholz, 2008; Webb, 2005; Woo, 2009). In other words, the EfS website has been reported to be able to promote learning and improve understanding of participants from different typology groups, which present different levels of understanding of sustainability issues at Lanalhue Lake.

Table 7.5. Participants' reported learning and change in understanding after their first visit to the EfS website (n = 24, *theme code* 16.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 7)	**Group 2** (n = 8)	**Group 3** (n = 9)	**Totals***	
				L3	**L2**
16.05 Learning / Improved understanding	5	5	8	**18**	**24**
Learned new things	2	4	5	**11**	
Learned more about lake's issues	4	1	2	**7**	
Deeper understanding	4	2	-	**6**	
16.10 Thinking shift	-	-	-	**-**	**10**
New perspective towards issues	1	4	4	**9**	
Transformative understanding	-	-	2	**2**	
Acquired ecological perspective	-	2	-	**2**	
16.15 New motivation / interest	-	1	1	**2**	**6**
Interest in issue stimulated by website	2	2	1	**5**	
16.30 Reflective process about environmental care	-	3	-	**3**	**3**
Totals (n° responses)	**18**	**24**	**23**	**65**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

For example, Julia from Group 2 answered to question Q4: “Definitely yes, definitely yes, a lot, a lot, about the luchecillo… The analysis is very precise, is like it immediately clarifies any doubt” (Julia, post-intervention interview, *seq.* 234). And Mateo from Group 2, who lived in Cañete and previously reported a high interest and a poor knowledge regarding Lanalhue Lake issues, achieved a *deeper understanding* (*theme code* 16.070; level-3 subtheme) regarding local people’s responsibility over the lake. He answered to question Q4a:

> Yes, yes (…), it’s something that really worries, and in certain way [the website] makes the point that we are all responsible for it. We who live close to the lake are responsible… and to understand that to avoid the pollution of the lake may not necessarily involve huge actions, but just small ones.
>
> (Mateo, post-intervention interview, *seq.* 277.01)

Similarly, Rafael from Group 1 reported in question Q4 that he learned new things, and that he was able to confirm other beliefs:

> Yes, yes, about the luchecillo, and even things that I had no idea of, and I could also confirm that is a real problem, maybe it is a natural process, but it definitely has a negative impact socially and recreationally. In fact sometimes I go kayaking and it really [the luchecillo] affects you… Yes very well, I liked that we met and have been able to learn all this!
>
> (Rafael, post-intervention interview, *seq.* 254)

Concerning participants from Group 3, Rosario answered to question Q4 “very interesting, I learned many things that I didn’t know about” (Rosario, post-intervention interview, *seq.* 197.01); and Marcelo, who was one of the four participants who reported that the *cause* of sustainability issues at Lanalhue Lake was the ‘arrival of black-necked swans’ in large numbers (see Section 7.2.2.2), which was considered as being a strongly-rooted local myth or alternative conception in regard to the cause of sustainability issues at Lanalhue Lake, and thus demonstrating a low level of

understanding of such issues, after visiting the website reported the following (answer to question Q4):

> Yes, [I learned] what is 'native' and 'endemic', and also about the luchecillo, that there are many local myths about it, in fact within what was indicated as myths, I had previously believed in two of them about the cause of the luchecillo: that it came from the swans' faeces, and that it came from a motor boat.
>
> (Marcelo, post-intervention interview, *seq.* 237.01)

Regarding the second most recurrent level-2 subtheme from answers to questions Q4 and Q4a, 10/24 participants were coded 'thinking shift' (*theme code* 16.10). Note that 9/10 of these participants were from Group 2 (n = 4) and Group 3 (n = 5). Here, the most recurrent level-3 subtheme was 'new perspective towards sustainability issues' (*theme code* 16.110), with 9/10 participants scoring. One answer that illustrates this type of new perspective, or *thinking shift*, over sustainability issues is the answer (to question Q4a) from Javier (Group 3), who had lived in Contulmo for less than a year and worked as a teacher at a local secondary school:

> Yes, of course. Now I have gained some elements and technical explanations that generally one doesn't have access to. Regarding the Lanalhue Lake issues I can now forget about the idea that it is just a problem affecting tourism, but that there are a series of factors involved that one is not aware of. So with no doubt after visiting the website I finally understand the origin of the issues.
>
> (Javier, post-intervention interview, *seq.* 273.02)

As well, Rosario (Group 3) responded to a follow-up question to Q4, 'Is there anything that drew your attention over other things?': "Eeh especially regarding what I personally contribute to the pollution [of the lake] myself as an individual, from ignorance" (Rosario, post-intervention interview, *seq.* 217), highlighting how she realized that, due to a lack of knowledge, she was also part of the cause of sustainability issues. Or Emilio (Group 2), who after visiting the website realized that some local people do care

about the lake, in opposition to his prior beliefs, and thus acquiring a new perspective in that regard:

> To say the truth yes, especially regarding… One usually thinks that people are not really aware about environmental care, however within the Solutions sections I saw some proposed solutions from the local community that are really good, demonstrating that people do know something and are aware and interested about environmental care.
>
> (Emilio, post-intervention interview, *seq.* 246.01)

Moreover, 2/10 participants from Group 2 were coded under subtheme 'acquired ecological perspective' (*theme code* 16.115), this being one of the key objectives of the EfS website: to promote a *transformative* type of learning and understanding towards the acquisition of ecological and holistic perspectives over sustainability issues. Julia (Group 2), who lived in Cañete and worked at the one of the local councils, transformed her understanding from just blaming the black-necked swans' arrival for the eutrophication of the lake, to gain a more ecological / holistic perspective over Lanalhue Lake's sustainability issues:

> Yes it definitely broadens it [understanding of sustainability issues]… because I use to blame just the swans. Now I know that we all contribute in many aspects, the deforestation, the dwellings development around the lake… And the other thing is that I did not know that the luchecillo was beforehand on the lake and that it suddenly bloomed because of all these issues. To me it was very interesting, I know more…
>
> (Julia, post-intervention interview, *seq.* 261.02)

And Emilio (Group 2), also from Cañete, who was able to bring together different views and knowledge and form for himself an integral perspective, achieving a holistic *big picture*:

> You know what? Is like something came to me… because usually one has scattered views, but when you focus it on an area, on an ecosystem [like on the website], you can bring together the

> information, and you can wrap-up the information, and take different views to form yourself a global view, so definitely yes.
>
> (Emilio, post-intervention interview, *seq.* 270)

And 2/10 participants from Group 3 indicated a 'transformative understanding' (*theme code* 16.105), as for example, Soledad (Group 3), who stated:

> Interesting, it seems to me to be very interesting because I didn't have much knowledge about it [eutrophication of the lake], and now I realize that it is ourselves, that we are polluting the lake too.
>
> (Soledad, post-intervention interview, *seq.* 196.01)

From the above analysis related to the two most recurrent level-2 subthemes from Table 7.5, it can be concluded that it appears that all participants from all three different typology groups regarding their level of understanding of sustainability issues at Lanalhue Lake *improved their understanding* after visiting the EfS website, but in different ways. Participants' closer to the *higher* end of understanding (Group 1 and high end of Group 2) prior to visiting the website tended to achieve a *deeper understanding*, suggesting that participants who already have a *good-to-high* level of understanding of sustainability issues at Lanalhue Lake were able to learn *even more*. For example, Ramiro (Group 1) who indicated achievement of a deeper understanding from enhancing previous knowledge that was not quite clear to him:

> Well, to see the harvesting machine working, eeh.. to discover some things or some information that one usually does not have much clarity about, and here [on the website] I find a lot of data, a lot of information. There are many things [on the website]"
>
> (Ramiro, post-intervention interview, *seq.* 249)

Or Ernesto, who pointed to a deeper understanding related to scientific aspects, as well as to some environmental terminology: "Yes, especially scientific aspects, and what is the meaning of some new things, or some

new environmental terms, that are a bit unknown" (Ernesto, post-intervention interview, *seq.* 256).

Whereas participants on the *lower* end of understanding (lower end of Group 2, and Group 3), tended to *learn new things* and to go through a *thinking shift* process over sustainability issues at Lanalhue Lake, such as in the case of Javier presented above (*seq.* 273.02). Arguably these participants are the most likely ones that could go through a *thinking shift* process (over participants with a pre-existing higher level of understanding), as the low end of Group 2, and Group 3, include participants with a *mid-to-low* level of understanding of sustainability issues at Lanalhue Lake, thus providing more potential for such thinking shift process to occur after achieving a better understanding of the issues, and thus having a clearer perspective of them. The extreme cases of this analysis are Julia and Emilio, both from the lower end of Group 2, who were able to *acquire an ecological perspective* over sustainability issues, after visiting the EfS website.

In regard to the third most recurrent level-2 subtheme from Table 7.5, it is related to types of *motivation* or *interest* promoted by the EfS website: 6/24 participants were coded under level-2 subtheme 'new motivation / interest' (*subtheme* 16.15), with five of those participants (i.e. from each typology group) coded under 'interest in issue stimulated by the website' (*theme code* 16.155). For example, Ana responded to question Q4a:

> Eeh, for example the solutions section, I would like to review it further on the website, it has some solutions that I would have never thought of, and solutions that are really practical but you do not know of, but that now are available to me.
>
> (Ana, post-intervention interview, *seq.* 265.02)

And concerning the least recurrent level-2 subtheme, 3/24 participants from Group 2, Nora, Mario and Mateo, were coded under subtheme 'reflective process about environment' (*theme code* 16.30). Nora, for example, went through a reflective process in regard to her own and other

local's role in relation to caring for the lake, and the importance of it for the local tourism industry. She stated:

> Yes, yes… and as well I think is like a *mea culpa* [i.e. acknowledgement of one's fault], it is us who live here, who live in this area who should be worrying and organizing groups, I don't know, group of friends, and do things about it. And myself, I don't know, is like I have mixed feelings because I love nature but I don't do anything for it. What do I do? I don't litter, the other day I was in a lookout on the way to Lanalhue Lake, and I was taking pictures and suddenly I realize there was rubbish littered all around me, and it's a lookout! I mean people come, I come and stop for a snack and you see all this, what a shame! Shame. What is the tourist that visits this area going to think about this? Cañete is a touristic place, a lot of people here lives from tourism.
>
> (Nora, post-intervention interview, *seq.* 271)

It can be suggested that participants who go through a reflective process, which may include affective and/or emotional domains like in the case of Nora, may be more likely to achieve a *thinking shift* around sustainability issues at Lanalhue Lake. This is because it has been reported that arousing emotional domains and reflective processes over sustainability issues and challenges, through meaningful and real-life issues, are important factors that may contribute to learning, and to the adoption of ecologically informed attitudes and practices (Ballantyne & Packer, 2005; Eich & Schooler, 2000; Sipos et al., 2007). As well, learners who go through a reflective process may more easily accommodate new information, achieve change in their conceptual structure towards sustainability issues, and thus improve their level of understanding (Duit & Treagust, 2003; Kelly, 1991; Menzel & Bögeholz, 2008; Vosniadou, 1992). In fact, Mateo (Group 2), who was also coded under 'reflective process about environment', and who, as noted earlier, actually achieved a *deeper understanding* after realizing local people's role in regard to sustainability issue, has also shown evidence of going through a *thinking shift* process (*seq.* 277.01).

Before highlighting other overall findings from this section, it must be noted that three participants, i.e. Pamela (Group 1), Mario (Group 2), and Mariana (Group 3) reported *not improving their understanding* in one of their answers to the two questions addressed in this section (questions Q4 and Q4a, post-intervention interview). However, the three of them did report *improvement of understanding* or *learning* in the other question, which is what is being reported in Table 7.5.

For example, although Mario (Group 2) reported a *deeper understanding* in question Q4, in relation to learning something new from the website, he was also coded under level-2 subtheme 'did not improve understanding' (*theme code* 16.20) in question Q4a related to improving understanding of sustainability issues at Lanalhue Lake. As he points out in his answer, he was not sure if he improved his knowledge. But, he found the EfS website to be challenging by engaging him to reflect about the fact that the lake had sustainability problems and issues:

> I don't know if [my understanding] changed, but I think the good thing about the website is that it strikes you with the sustainability topic. I mean it immediately makes you think that the lake has a problem, and that for all of us who live nearby the lake and that care for the lake is worrying, just the name of the website '*Lanalhue Sustentable'* definitely makes us raise the alarm.
>
> (Mario, post-intervention interview, *seq.* 260)

Pamela (Group 1), reported (in question Q4a) that although she did not improve her understanding, she was able to reinforce prior knowledge: "it hasn't changed, but it has been reinforced as I have been able to confirm many things that I think about it" (Pamela, post-intervention interview, *seq.* 264). This answer further supports the idea of including a variety of information to satisfy each individual's needs (Brookfield, 1986; Galbraith, 1990; Menzel & Bögeholz, 2008). In the case of Pamela, as she already has a *high* level of understanding and felt that she did not improve her understanding, at least the EfS website was able to confirm and reinforce prior knowledge.

Finally, Mariana (Group 3), who lived in Contulmo, and had reported a moderate interest and a poor knowledge about Lanalhue Lake issues, indicated that she *learned more about lake's issues* in question Q4a, but was coded under subtheme 'did not improve understanding' in question Q4. The following passage from her interview helps to clarify her answer:

> *Researcher (R): Q4. Did you learn something new after visiting the website?*
>
> Mariana (M): No, because I already knew that, that you have to clean the lake and all that.
>
> *R: Which parts of the website did you visit the most?*
>
> M: The one dealing with the ways of cleaning the lake, about the pollution of the lake.
>
> *R: The Solutions part?*
>
> M: Yes that one.
>
> *R: Any other?*
>
> M: No, just that one.
>
> *R: And you already knew about those kinds of solutions and recommendations?*
>
> M: Of course, everybody knows that one has to clean the lake, take out all the luchecillo you can, keep it clean, everybody knows that.
>
> (Mariana, post-intervention interview, *seq.* 251)

As reported by Mariana, she only visited the Solutions section, where she browsed information regarding recommendations to protect the lake from pollution and clean the shores of luchecillo. She also reported that in Contulmo, where she lived at the time of the intervention, that the recommendations on the website were common knowledge. Note that, as reported earlier, Contulmo is the closest city to the lake, so it is possible that the local inhabitants would be aware of ways to care for the lake.

Regarding overall findings from this section, one feature to be highlighted is that all participants from all three typology groups reported that they *did learn* something, it can be said that some key concepts from the theoretical model for the development of EfS websites have been illustrated here. Firstly, there is evidence that the website did reach the

broader audience of the target community, meaning addressing a wide range of conceptions and needs with a variety in depth and sophistication of information (Brookfield, 1990; Dohn, 2009; Menzel & Bögeholz, 2008; Webb, 2005; Woo, 2009), as shown by data from Table 7.5, where participants from all typology groups reported some sort of *learning process*.

For example, the inclusion of more sophisticated scientific information allowed Ernesto (Group 1, *seq.* 256) to better understand some environmental terminology associated with local sustainability issues, whereas Rosario from Group 3, who reported having learned many things (*seq.* 197.01), may have achieved such learning from the less sophisticated information contained on the website, especially designed for users without an advanced knowledge of sustainability issues.

Secondly, there is evidence that the website illustrated the notion of promoting learning by enhancing users' experiences with multimedia affordances (Greenhow et al., 2009; Mayer & Moreno, 2002; Sangin et al., 2008; Webb, 2005). The literature stresses that resulting affordances are shaped by both the social and cultural context in which they are designed, and by users' social and cultural backgrounds (Dunn & Marinetti, 2008; Knight et al., 2009; McGrenere & Ho, 2000; Selinger, 2004; Webb, 2005; Woo, 2009). Affordances such as videos showing the luchecillo harvester machine in operation permitted some participants to improve their understanding, like Ramiro above (Group 1, *seq.* 249); or the answer from Mario (Group 2), coded under subtheme 'deeper understanding', which also points to the impact that the use of multimedia affordances can have in EfS learning. Mario responded to a follow-up question 'is there anything that you did not know before and now you have learned?' with the following:

> I was impressed by the degree of damage that the luchecillo is making on the shores of the lake. I mean you normally see it, but to see it on the pictures is way more impacting. You can see it from

> the road, from the shores, etc., but to see it on such clear and sharp pictures really impacts.
>
> (Mario, post-intervention interview, *seq.* 233.01)

Here, the use of pictures assisted Mario to realize the ecological effects produced by the luchecillo on the shores of the lake.

And thirdly, related to the level-2 subtheme 'thinking shift', is the notion of promoting *transformative learning* around sustainability issues as critical for EfS (Huckle & Sterling, 1996; Myers & Kent, 2005; Orr, 2004; Räthzel & Uzzell, 2009; Sterling, 2001). There is evidence for this from two participants in Group 3, i.e. Soledad and Marisol. As presented above, Soledad (*seq.* 196.01) reported that, based on her visit to the EfS website, she was also part of the problem; and Marisol, who stated: "regarding the luchecillo issue, [I learned] that there are many myths, and from what I was able to read, I could clarify some doubts I had" (Marisol, post-intervention interview, *seq.* 241.02), suggesting a type of *transformative understanding*, as Marisol was able to identify locally-rooted myths and clarify some uncertainty she had around those myths, achieving a better conception, i.e. cognitive framework (Menzel & Bögeholz, 2008), over local sustainability issues. Note that a clearer understanding over sustainability issues precedes a competent action (Jensen, 2002; Palmer, 1995).

In summary, findings from this section addressing participants' reported learning from the use of the EfS website indicates that the website allowed participants (regardless of their pre-intervention group typology) to learn new things, mostly related to the sustainability of the lake. However, there was a tendency for different learning processes and outcomes to occur, depending on typology groups. In this sense, the EfS website appeared to satisfy different participants' needs in a way that was meaningful to each one of them.

7.3.1.1 Participants' post-intervention level of understanding of sustainability issues

Based on pre-intervention typology groups determined in Section 7.2.3, and on above findings related to participants' learning and change in understanding after their first visit to the EfS website, new levels of understanding can be established for some participants. As highlighted in the *ecological literacy framework*, systems thinking and ecological literacy are the two key concepts defining typology groups. This means that *typology levels of understanding* of sustainability issues are defined by evidence of presence of some degree of either systems thinking and/or ecological literacy in participants' answers.

Considering the three level-3 subthemes identified under *thinking shift* (see Table 7.5), and the score system used to determine pre-intervention typology groups, the following score system was used to determine new post-intervention typology groups. For the two level-3 subthemes implying a major *thinking shift* (in terms of the *ecological literacy framework*; n = 4/10), i.e. 'transformative understanding' and 'acquired ecological perspective', 3 points were given. For level-3 subtheme 'new perspective toward issues', involving a minor *thinking shift*, 1 point was given (n = 6/10). For participants indicating no *thinking shift*, no points were given.

Table 7.6 presents post-intervention typology groups related to new *levels of understanding* of sustainability issues after participants' first visit to the EfS website. New scores for each participant, and comparison with scores from pre-intervention typology groups (see Table 7.4) are shown. Data indicates that two participants from pre-intervention Group 2, Emilio and Julia, were upgraded to Group 1, after indication of *acquisition of ecological perspective*. And three participants from pre-intervention Group 3 were upgraded to Group 2: Soledad and Marisol reported a *transformative understanding* of sustainability issues at Lanalhue Lake; and Javier, who was in the high end of Group 3 and reported *new perspectives* towards sustainability issues.

Table 7.6. Post-intervention typologies of participants regarding their level of understanding of the sustainability issues present at Lanalhue Lake, after their first visit to the EfS website.

Participant (Original score)	**New perspective**	**Transfor-mative understan-ding**	**Ecological perspective**	**New score**	**Group** (n)
Romina (12)	-	-	-	12	**1** (9) Score ≥ 8
Doris (10)	1	-	-	11	
Ramiro (10)	-	-	-	10	
Ernesto (10)	-	-	-	10	
Pamela (8)	-	-	-	8	
Rafael (8)	-	-	-	8	
Manuel (8)	-	-	-	8	
Emilio (5)	-	-	3	8	
Julia (5)	-	-	3	8	
Benjamin (7)	-	-	-	7	**2** (9) Score = 5-7
Pablo (7)	-	-	-	7	
Soledad (4)	-	3	-	7	
Mario (6)	-	-	-	6	
Mateo (5)	1	-	-	6	
Nora (5)	1	-	-	6	
Javiera (5)	-	-	-	5	
Javier (4)	1	-	-	5	
Marisol (2)	-	3	-	5	
Mariana (4)	-	-	-	4	
Oscar (3)	1	-	-	4	

Participant (Original score)	**New perspective**	**Transfor-mative understan-ding**	**Ecological perspective**	**New score**	**Group** (n)
Rosario (3)	1	-	-	4	**3** (6) Score ≤ 4
Ana (3)	-	-	-	3	
Maria (3)	-	-	-	3	
Marcelo (2)	-	-	-	2	
Totals	**6**	**2**	**2**	-	-

Findings from Table 7.6 indicate an *increase* of the systems thinking and ecological literacy level of participants regarding their *understanding level* of sustainability issues at Lanalhue Lake, based on their first visit to the EfS website. Therefore it can be concluded that the EfS website showed evidence of being able to promote not only a *better understanding*, but also a *transformative understanding*, including evidence of acquisition of *ecological literacy* in Emilio and Julia.

7.3.2 Participants' change in interest towards Lanalhue Lake

Participants' self-perceived change in interest towards Lanalhue Lake, after their first visit to the EfS website, was evaluated by means of question Q4b of the post-intervention interview: 'based on your visit to the website, do you have a new interest or concern towards the sustainability of the lake?', with a total of 20/24 participants providing answers. These answers were analysed and coded under two level-2 main subthemes, using theme code 16.00 'participants' learning / understanding change from use of the website' of the Codebook. Table 7.7 presents this data associated with change in interest prompted by the EfS website, with attention to scores for each typology group.

Table 7.7. Participants' reported change in interest towards Lanalhue Lake's sustainability issues, after their first visit to the EfS website (n = 20, *theme code* 16.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 6)	**Group 2** (n = 8)	**Group 3** (n = 6)	**Totals***	
				L3	**L2**
16.15 New motivation / interest	3	5	2	**10**	**20**
Interest for Lanalhue Lake issues	2	2	2	**6**	
Reinforcement / increase of prior interest	2	1	2	**5**	
Interest in issue stimulated by website	1	-	1	**2**	
Interest in disseminating website	1	1	-	**2**	
16.30 Reflective process about the environment	-	1	-	**1**	**1**
Totals (n° responses)	**9**	**10**	**7**	**26**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

All (20/20) respondents to this question reported a new *motivation* and/or *interest* towards Lanalhue Lake's sustainability issues after their visit to the EfS website. Within this level-2 subtheme 'new motivation / interest' (*theme code* 16.15), four level-3 subthemes were identified:

- 6/20 participants reported a new interest for Lanalhue Lake issues;
- 5/20 participants reported having reinforced and/or increased prior interest;
- 2/20 participants reported an interest on issues stimulated by the website;
- 2/20 participants reported an interest in disseminating the EfS website.

In relation to pre-intervention typology groups, data is scattered across the three different groups, without any clear indication of the type of motivation and/or interest prompted by the website over a particular typology group. Nonetheless, an interesting analysis is to compare data from Table 7.7 with data from Table 6.2 dealing with levels of interest towards Lanalhue Lake sustainability issues reported by participants during the pre-intervention questionnaire, prior to their first visit to the EfS website (see Section 6.2).

In that case, answers to Q10 of the pre-intervention questionnaire, 'please rate your interest in environmental/sustainability issues at Lanalhue Lake', showed that:

- 16/24 participants reported a *high* interest;
- 6/24 participants indicated a *moderate* interest;
- And Nora (Group 2) and Rosario (Group 3) reported a *low* interest.

After their first visit to the website, Nora (Group 2) and Rosario (Group 3), who were the only two participants reporting a *low* interest towards Lanalhue Lake issues on the pre-intervention questionnaire, appeared to have changed their views, showing evidence of *new interest* over the lake. Nora responded to question Q4b of the post-intervention interview: "of course, on the environmental side yes of course, on the Lanalhue Lake side with a greater reason, because I am from the area" (Nora, post-intervention interview, *seq.* 296). This demonstrated a new interest over environmental matters, and over local matters related to Lanalhue Lake, based on a place-related meaningfulness feeling by being 'from the area'. Rosario also reported a change in interest, especially over things that are more immediate to her as is the rubbish littering issue:

> Yes, actually when I had the chance before to read about the lake, to know what was going on I never really did it, and now I got worried about the rubbish littering issue, which is maybe what is more closely related to what we do here, to what we have within reach.
>
> (Rosario, post-intervention interview, *seq.* 298)

Regarding the 6/24 participants that declared a *moderate* interest towards Lanalhue Lake in the pre-intervention questionnaire, 4 of them reported a new motivation and/or interest towards Lanalhue Lake issues (i.e. with the remaining 2 participants not giving feedback to answer Q4b). For example Manuel, from Contulmo and considered an *historically* local community member, in the pre-intervention questionnaire he declared a moderate interest. However, after visiting the EfS website, he declared to have a new interest, and to also have reinforced prior levels of interest over knowing and caring about the lake: "without a doubt definitely yes, yes… and it also increased in me wanting to learn more, first, and to care and protect the lake, in second place" (Manuel, post-intervention interview, *seq.* 301.03).

Another example of a participant who first declared a *moderate* interest and after using the EfS website experienced a change in interest, is Maria, who stated that as she went through a learning process through the EfS website, new concerns appeared for her, with her hoping to be able to clarify those concerns though the EfS website: "I think that as you go on with learning more, concerns also appear and increase, but precisely one expects that through the website those concerns can be clarified, as one advances further on too" (Maria, post-intervention interview, *seq.* 284).

In regard to the remaining 14/20 participants who declared a *high* interest towards Lanalhue Lake in the pre-intervention questionnaire, and who provided feedback to question Q4b of the post-intervention questionnaire, the following figures present an overview of their interest towards Lanalhue Lake, after visiting the EfS website:

- 4/14 participants reported a general new motivation / interest;
- 4/14 participants reinforced prior interest towards the lake;
- 4/14 reported a new interest particularly over Lanalhue Lake's issues;
- 2/14 participants reported an interest to disseminate the website;
- And Doris (Group 1) reported new interest in issues stimulated by the website.

In regard to Mario (Group 2), the sole participant coded under the other level-2 subtheme 'reflective process about environment' (*theme code* 16.30) identified from answers to question Q4b, said:

> Even if it may sound a bit *cliché*, the reality is that the website invites [one] to get worry and concerned. It's true I didn't have much time to browse it but there is something concrete. Everybody talks about the Lanalhue Lake but you don't have anything, there is no book, or a lake's protection centre, a centre could be installed somewhere on the shores of the lake, with someone there to explain the good things of the lake and how to protect it. That would be a great thing to do, maybe put it on the Peleco side, I don't know, but the thing is that nothing has been done in that regard…
>
> (Mario, post-intervention interview, *seq.* 282.02)

Mario highlights how the website prompted him to think about the environmental care of the lake, and that to his knowledge there is no other source of information regarding Lanalhue Lake's issues apart from the EfS website, hence this being something useful for him. From a theoretical model and EfS point of view, it is something positive that the website in his case was able to prompt him into a reflective process over the environmental care of the lake, with the EfS website acting as a motivator. Thus, in terms of complexity theory in education, the website acted as an educational leader able to show the way towards ecological sustainability by empowering learners (Morrison, 2002).

An overview of this section addressing participants' change in *interest* over Lanalhue Lake's sustainability issues is that all participants who provided feedback to question Q4b appeared to have gained a new *motivation* or *interest* towards the lake, or at least in some cases, to have *reinforced* and *increased* previous levels of interest towards the lake, meaning that the website seemed meaningful to participants. In the view of activity theory (AT), and as reviewed in Section 6.3 of the previous chapter, *motivations* can be regarded as *outcomes* of the activity system formed by the interaction of the EfS website with participants. And in turn, motivations as outcomes can become part of a new third-generation *expansive activity*

system, where outcomes from one activity system can be used by another activity system to reach other goals (Krasny & Roth, 2010; Yamagata-Lynch, 2007)).

In the case of the EfS website, its activity system is set to act as an *educational activity system* that nurtures itself, and where *motivations* as outcomes from a first-level interaction between users and the website would be used to become *subject* of a downstream second-level expansive activity system, where the goal would be to promote *understanding*. This means that new *interests* and *motivations* could be seen as a previous step in the promotion of *understanding* of sustainability issues.

7.3.3 Summary

As a summary of Section 7.3 dealing with change in understanding of sustainability issues at Lanalhue Lake by participants, findings from the first section addressing participants' reported learning and change in understanding after their first visit to the EfS website are principally two. First, the EfS website promoted change in understanding in the majority of participants, regardless of their typology group; and second, there was a tendency to different types of change in understanding processes depending on typology groups. In particular, participants from Group 1 tended to achieve a *deeper* understanding over what they already knew about Lanalhue Lake's issues, without indication of *thinking shift* processes.

Whereas participants with a *low* to *medium* level of understanding, i.e. Group 2 partially and Group 3, rather tended to learn *new things*, and to go through *thinking shift* processes, like acquiring new perspectives towards issues, or directly achieving *transformative understanding* types of change in understanding, this being a key EfS goal in the present study. These findings then permitted the establishment of new typology groups (post-intervention), with evidence of an *increase* of the ecological literacy

level of participants regarding their *understanding level* of sustainability issues at Lanalhue Lake, based on their first visit to the EfS website.

Then Section 7.3.2 assessed participants' change in interest and/or motivation towards Lanalhue Lake, after visiting the EfS website. Here findings indicate that all participants presented some sort of a new *motivation* and/or *interest* towards Lanalhue Lake's issues, and for those participants already presenting a high level of interest towards the lake prior to this intervention, they were able to reinforce and/or even increase their previous levels of interests. Similar to findings from the last chapter related to participants' perception towards the EfS website, evidence suggests that the website was meaningful to the great majority of, if not all, participants.

In relation to this, theoretical considerations from activity theory regard the promotion of motivations as *outcomes* of the educational system underpinned by the EfS website, and that in turn such motivations could carry participants to engage in new activity systems also underpinned by the website that could lead to *understanding*. Hence, great interest towards the lake prompted by the EfS website from participants may imply change in understanding of sustainability issues, as shown in Section 7.3.1.

As well, it appears that the EfS website was able to satisfy different types of needs in participants from different typology groups, prompting different types of *understanding change* processes. Another key finding from this section is that the EfS website was able to promote the acquisition of an ecological/holistic perspective in two participants, i.e. Emilio (Group 2) and Julia (Group 2), regarding the sustainability issues at Lanalhue Lake, who later were placed in post-intervention typology Group 1. This also supports other findings regarding the likelihood of participants with a *medium* to *good* level of understanding (Group 2) to undergo such transformative process in their understanding of sustainability issues.

Finally, it must be noted that the research question addressed in this section, regarding the ability of websites to promote understanding of sustainability websites at the community level or not, was addressed: the EfS website *could* and *did* appear to improve understanding levels of sustainability issues among community members, in the context of Lanalhue Lake. In the coming section, this key finding is examined for change *over time*.

7.4 Change in understanding over time

This section presents findings from the follow-up phase regarding participants' change in understanding of sustainability issues at Lanalhue Lake *over time*. All 24 participants were invited to take part in the follow-up phase (i.e. carried out 5 months after participants' first visit to the EfS website) and 18 participants responded positively (i.e. phase 4d). Of these 18, 17 reported in Section 6.4 (Q1 of the follow-up survey) that they did revisit the EfS website during the follow-up period, and only one participant, i.e. Marcelo (post-intervention Group 3), did not revisit the EfS website at all (see Section 6.4.1 for details). Hence, the following analysis only considers those 17 participants who revisited the EfS website.

Section 7.4.1 presents findings related to participants' change in understanding related to the *luchecillo*, i.e. eutrophication process at Lanalhue Lake, this being the main topic addressed on the EfS website. After that, Section 7.4.2 presents findings related to participants' change in understanding regarding *other issues* present at Lanalhue Lake; and new follow-up typology groups, based on revisits. Finally, Section 7.4.3 summarises overall findings from this section.

7.4.1 Participants' change in understanding over time regarding the luchecillo

Participants' reported change in understanding *over time* based on the use of the EfS website during the follow-up period was assessed by means of the following two questions from the follow-up survey:

- Q2. Has your level of understanding about the issues related to the *luchecillo* at Lanalhue Lake changed since your first visit to the EfS website? (*Yes / No*)
- Q2a. If yes, how has your understanding changed?
- Answers to question Q2 show that:
- 14/17 participants indicated a change in understanding regarding issues related to the luchecillo;
- 2/17 participants indicated '*do not know*', i.e. Mario (post-intervention Group 2) and Oscar (post-intervention Group 3), reporting being unsure if their understanding over luchecillo issues changed;
- 1/17 participant, i.e. Ramiro (post-intervention Group 1), reported no change in understanding over issues related to the luchecillo.

Regarding those 14 participants who did report a change in understanding over sustainability issues related to the luchecillo, answers in relation to post-intervention typology groups indicate that:

- 7/14 participants were from Group 1 (n = 8)
- 5/14 participants were from Group 2 (n = 6)
- 2/14 participants were from Group 3 (n = 3)

These figures indicate that the majority of participants (n = 14/17) reported a *change in understanding* regarding sustainability issues related to the luchecillo, based on their re-visits to the EfS website during the follow-up period. This change in understanding was scattered across all three typology groups, suggesting that the EfS website was able to promote change in understanding in participants presenting different levels of ecological literacy regarding sustainability issues at Lanalhue Lake.

On the other hand, Mario (post-intervention Group 2) and Oscar (post-intervention Group 3) reported being unsure about whether their level of understanding of issues related to the luchecillo had changed or not after their revisits to the EfS website. Note that both participants reported in Section 6.4 that they revisited the EfS website between 4 to 6 times, on

average 5 minutes per visit in the case of Mario, and on average 20 minutes per visit in the case of Oscar. Moreover, Mario reported having mostly revisited the following sections: 'Lanalhue Lake', 'Sustainability', 'The Luchecillo', and 'Links to websites of interest', but only during short periods of time when compared to the majority of participants (see Table 6.13; only two participants revisited the website for short periods of time, i.e. 5 minutes on average, Pablo being the other one).

The fact that Mario was in the upper end of Group 2 initially, hence presenting a *good* level of understanding before the intervention and demonstrating so in his responses to questions about his understanding, and that he spent short periods of time on average during his revisits on the website, may explain why he felt he did not achieve a clear change in understanding over issues related to the luchecillo. Concerning Oscar (post-intervention Group 3), he reported earlier (Section 6.4) that he primarily focused his revisits in reviewing the 'Documents' section, which may explain why he felt he did not change his understanding over luchecillo issues. Nonetheless, which type of documents he reviewed the most, i.e. related to the eutrophication of Lanalhue Lake or not, is unclear.

Ramiro (Group 1) was the only participant who reported not having changed his understanding based on revisits to the EfS website. His levels of understanding and ecological literacy in regard to sustainability issues at Lanalhue Lake were already *high,* prior to the intervention. So the fact that he reported no change in understanding may be explained because he already had a high level of understanding, with not much more to learn and understand about the luchecillo from the information on the EfS website.

Considering the 14 participants who did report a change in understanding, their answers to Q2a 'If yes, how has your understanding changed?' showed the presence of 3 recurrent subthemes, when analyzed under theme code 21.00 'change in understanding over time' of the Codebook.

Table 7.8 presents these three recurrent subthemes, with attention to scores for each post-intervention typology group.

Table 7.8. Participants' reported change in understanding of issues related to the luchecillo, based on revisits to the EfS website during the follow-up period (n = 14, *theme code* 21.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 7)	**Group 2** (n = 5)	**Group 3** (n = 2)	**Totals***	
				L3	**L2**
21.05 Change in understanding	-	-	-	-	**14**
Better understanding of luchecillo issues	6	2	2	**10**	
Acquired ecological / systems thinking perspective	-	3	-	**3**	
Transformative understanding re luchecillo issues	2	-	-	**2**	
Totals (n° responses)	**8**	**5**	**2**	**15**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

Data from Table 7.8 indicates that the most recurrent subtheme for question Q2a was 'better understanding of luchecillo issues' (*theme code* 21.055), with 10/14 participants from all three typology groups scoring in this theme. This suggest that these participants achieved a *better understanding* type of change in sustainability issues related to the luchecillo, based on revisits to the EfS website during the follow-up period. For example, Pamela (post-intervention Group 1) reported that she better understood the causes that prompted the accelerated proliferation of the luchecillo on the lake, and what local councils had done to manage this:

> I only knew about what was the problem and not much about the luchecillo itself. I had the opportunity to learn on the website more about the luchecillo in regard to the causes of its proliferation

> (principally anthropogenic causes), and the way in which Cañete and Contulmo councils are dealing with it to eradicate it.
>
> (Pamela, follow-up survey, *seq.* 445)

Julia from Group 1 (pre-intervention Group 2), achieved a better understanding by learning about positive aspects of the luchecillo that she was not aware of:

> I use to think that [the luchecillo] only had a negative aspect, but I learned that its existence was also required to clean the lake. So I understood that it has a positive aspect that contributes towards the purification of the lake.
>
> (Julia, follow-up survey, *seq.* 442)

And finally, one example regarding achievement of a *better understanding* from participants from Group 3 is the one from Maria, who firstly regarded the luchecillo as something inoffensive, but later realised that it actually does have some negative aspects, and also which were the causes of its proliferation:

> First I thought that it was just a plant that did not cause any damage to the waters [of the lake], after reading I understood that it is an invasive plant that proliferated mainly due to man's intervention, and due to bad management of the [sewage] waters (that being what I understood). (Maria, follow-up survey, *seq.* 443)

The above quotes from Pamela (Group 1), Julia (Group 1) and Maria (Group 3) illustrate how the EfS website was able to promote a *better understanding* in the majority of participants from the three different typology groups, with no clear tendency towards a particular typology group regarding achievement of a *better understanding* over luchecillo issues. This suggests that the EfS website was able to promote such change in understanding in participants presenting different prior levels of understanding and of ecological literacy, regarding sustainability issues at Lanalhue Lake. In turn, this suggests that theoretical considerations implemented in the website design regarding addressing characteristics

and needs of the broader target audience have succeeded in terms of promoting a better understanding of sustainability issues in participants from different typology groups.

Concerning the second most recurrent subtheme from Table 7.8 ‘acquired ecological / systems thinking perspective’ (*theme code* 21.070), data indicates that 3/14 participants achieved this type of understanding, i.e. Pablo, Mateo and Javiera. In this case though, there is a tendency towards this happening only within participants from Group 2 (post-intervention typology), thus indicating similar findings to Section 7.3.1, where the only two participants that presented such a type of change in understanding after visiting the EfS website for the first time were also from Group 2, i.e. Julia and Emilio (now both in Group 1). In that opportunity, as in the present one, acquisition of an ecological perspective, or to achieve a deep understanding of the relationships between sustainability issues and the social, cultural and/or natural dimensions at Lanalhue Lake, appeared to be more likely to occur in participants that already presented a *good* level of understanding, but that had not yet acquired an ecological perspective (as Group 1 participants showed).

As an example, Mateo presented this type of change in understanding by stating that he could understand that the luchecillo was no longer something external to him: “[My understanding has changed] in the sense of our responsibility to its existence, and no longer as something that grows in the lake that is not related to me” (Mateo, follow-up survey, *seq.* 453).

Concerning the least recurrent subtheme from Table 7.8 in regard to types of change in understanding from participants during the follow-up period, 2/14 participants were scored under subtheme ‘transformative understanding re luchecillo issues’ (*theme code* 21.060), these being Doris and Rafael from Group 1. This may imply that change in understanding regarding issues related to the presence of luchecillo at Lanalhue Lake in the form of a *transformative understanding* towards

them, tended to occur in Group 1, including participants with a prior *high* level of understanding of sustainability issues at Lanalhue Lake. However, this goes against what could be expected compared to findings from Section 7.3.1, where change in *transformative understanding* was seen to occur exclusively within participants from Group 3 presenting a *low* level of understanding (see Table 7.5).

This could mean that a *transformative understanding* type of change in understanding may not be necessarily linked to *low* levels of understanding when evaluated *over time*, but to *high* levels of understanding, i.e. to achieve a further *higher understanding* though a *transformative process*, and coming from a prior high understanding. Or, it could also mean that *transformative understanding* types of change may not necessarily be linked to levels of understanding at all, but to individual backgrounds, expectations and needs, based in turn on different cognitive frameworks held by each participant (Menzel & Bögeholz, 2008); which then could lead to a *transformative understanding* where such change is possible and fertile. Coming findings in Section 7.4.2 may further clarify this point. Nevertheless, as a way to provide evidence in the *change over time* situation, here is a quote from Rafael (Group 1) who presented a transformative change by making clearer local myths regarding the luchecillo, and by exhibiting critical thinking towards actions undertaken so far by local authorities:

> I had never before heard the 'eutrophication' concept, and on the website it is very well explained. This took me to demystify people's diverse opinions regarding the lake, and to have a more critical view in regard to actions undertaken so far, like in the case of the luchecillo harvester machine. To have a management plan based on local scientific research is definitely needed.
>
> (Rafael, follow-up survey, *seq.* 452)

Note that Rafael explicitly provides evidence that the EfS website promoted critical thinking in him, this being another key objective from the

theoretical model for the development of EfS websites: to promote critical thinking over sustainability issues among community members.

Overall, findings from Table 7.8 indicate that the EfS website promoted change in understanding regarding luchechillo in the majority of participants from their revisits to the website. Similar to findings from previous sections, the type of change in understanding in some cases may be linked to prior levels of understanding of sustainability issues at Lanalhue Lake, represented here by the three different typology groups; and/or to participants' individual backgrounds, expectations and needs. The next section may help to further clarify this last point.

7.4.2 Participants' change in understanding over time regarding other issues

Participants' reported change in understanding *over time* based on the use of the EfS website during the follow-up period regarding *other issues* was assessed by means of the following two questions from the follow-up survey:

- Q3. Has your level of understanding about *other issues* related to Lanalhue Lake changed since your first visit to the EfS website? (*Yes / No*)
- Q3a. If yes, how has your understanding changed?

As the key sustainability issue addressed on the EfS website was the eutrophication process occurring at Lanalhue Lake, and considering that one of the key pedagogical objectives of the EfS website is to promote understanding over a wide range of sustainability issues (whether related to the eutrophication process or not, but related to local and global sustainability experiences and examples, and to sustainable living in general), question Q3 assessed if participants experienced a change in understanding based on the EfS website over *other issues* related to Lanalhue Lake. Participants' answers to question Q3 indicate that:

- 13/17 participants reported a change in understanding regarding *other issues* related to Lanalhue Lake;

- 3/17 participants i.e. Mario (post-intervention Group 2), Pablo (post-intervention Group 2) and Maria (post-intervention Group 3), reported being unsure if their understanding over other issues changed;
- 1/17 participant, Oscar (post-intervention Group 3), reported no change in understanding over other issues related to Lanalhue Lake.

In regard to the 13 participants who did report a change in understanding over *other issues* at Lanalhue Lake, distribution over typology groups indicates the following:

- 8/13 participants were from Group 1 (n = 8)
- 4/13 participants were from Group 2 (n = 6)
- 1/13 participant was from Group 3 (n = 4)

Overall, the above figures show that the majority of participants (n = 13/17) reported a change in understanding over *other issues* present at Lanalhue Lake, based on their visits to the EfS website during the follow-up period. However, in contrast to findings on change in understanding with respect to the *luchecillo*, where a more or less equally scattered distribution of scorings between the three typology groups was found, change in understanding over *other issues* tended to occur slightly more frequently within the *higher* end of typology groups, when compared to the other two typology groups. In addition, four recurrent subthemes were identified from answers to question Q3a (i.e. 'if yes, how has your understanding changed?'), which were evaluated against theme code 21.00 'change in understanding over time' of the Codebook. Table 7.9 presents these four recurrent subthemes, with attention to scores for each post-intervention typology group; note that Javiera did report a change in understanding but did not answer question Q3a, hence Table 7.9 presents data from n = 12 participants.

Table 7.9. Participants' reported change in understanding of other issues related to Lanalhue Lake, based on revisits to the EfS website during the follow-up period (n = 12, *theme code* 21.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 8)	**Group 2** (n = 3)	**Group 3** (n = 1)	**Totals***	
				L3	**L2**
21.05 Change in understanding	-	-	-	-	**12**
Better understanding of other issues at Lanalhue Lake	3	-	1	**4**	
Acquired ecological / systems thinking perspective	1	3	-	**4**	
Transformative understanding re other issues	4	-	-	**4**	
Better understanding re sustainable living	1	1	-	**2**	
Totals (n° responses)	**9**	**4**	**1**	**14**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

The three most recurrent subthemes from Table 7.9 have all the same number of participants scoring under them (n = 4/12), with data distributed differently over typology groups, depending on the type of change in understanding underpinning each subtheme. Three participants from Group 1 (post-intervention typology), i.e. Romina, Doris and Manuel, and Ana from Group 3 (post-intervention typology) were coded under subtheme 'better understanding of other issues at Lanalhue Lake' (*theme code* 21.0.56), indicating that for this subtheme, data is scattered between the *high* end and the *low* end of typology groups.

For example, Ana (Group 3) stated that her understanding regarding *other issues* associated to the sustainability of Lanalhue Lake changed in regard

to better understanding how to approach the rubbish littering and pollution problems existing at the lake (i.e. Ana lived close to the Lake): “[my understanding changed] in regard to how to avoid pollution from dwelling houses [around the lake]” (Ana, follow-up survey, *seq.* 460). Or Manuel (Group 1), who, based on his visits to the EfS website during the follow-up period, achieved a better understanding regarding the biodiversity present at the lake: “[My understanding changed] by increasing my knowledge regarding the flora and fauna associated to the lake” (Manuel, follow-up survey, *seq.* 468).

Regarding subtheme ‘acquired ecological / systems thinking perspective’ (*theme code* 21.070), findings from Table 7.9 indicate that this type of change in understanding related to *other issues* tended to occur among participants from post-intervention typology groups Group 1 and Group 2, in a similar way to findings regarding change in understanding over the *luchecillo*, which only occurred among participants from Group 2 (see Table 7.8). This supports previous suppositions in regard of such a type of change in understanding being more likely to occur within participants presenting *mid* levels of understanding of sustainability issues, i.e. Group 2. Moreover, Emilio from Group 1 (post-intervention typology), who was the only participant from Group 1 scoring under *acquired ecological perspective*, actually comes from Group 2 (pre-intervention typology), which reaffirms his new level of ecological literacy. A similar case occurs with Javier, now in Group 2 but previously in Group 3 (pre-intervention typology). Below follow the reports of such acquisition of an ecological perspective of change in understanding from Emilio and Javier:

- [My understanding changed] with an insight into other perspectives, I mean from the farmers’ point of view that carry on their activities on the shores of the lake, from the Mapuche worldview, and from the scientific point of view in relation to the ecological care [of the lake]. (Emilio, follow-up survey, *seq.* 463)
- It has helped me [the website] to understand the relationship between the lake and the community, especially in regard to

everything related to the indigenous people. (Javier, follow-up survey, *seq.* 465.01)

While Emilio achieved an holistic perspective of sustainability issues at Lanalhue Lake, in the sense of being able to identify and understand different views from different stakeholders that are related to the lake, Javier stressed his understanding of the relationship between the lake and the socio-cultural dimensions of sustainability issues interconnected to it.

For the last of the three most recurrent subthemes from Table 7.9, i.e. subtheme 'transformative understanding re other issues' (*theme code* 21.061), findings show that such a type of change in understanding occurred exclusively in the *higher* end of typology groups, with four participants from Group 1 scoring (i.e. Ramiro, Pamela, Rafael, and Julia). This finding is in line with the similar finding that was drawn in relation to change in understanding over the *luchecillo* (see Table 7.8), where only participants from Group 1 (n = 2/14, i.e. Doris and Rafael) were scored under the equivalent subtheme. In both cases then, a *transformative understanding* type of change in understanding was linked to *high* levels of understanding, when evaluated *over time*. Nonetheless, as pointed out in Section 7.4.1, this does not necessarily mean that *transformative understanding* types of change are not linked to individual backgrounds, expectations and needs, as suggested then.

In the case of Julia (pre-intervention Group 2), after having said during the post-intervention interview following her first visit to the EfS website that she used "to blame just the swans" (in regard to Lanalhue Lake's eutrophication process; *seq.* 261.02), but that the EfS website helped her to acquired a different (*ecological*) perspective over the issue her answer to question Q3a of the follow-up survey indicates a transformative understanding again, this time *over time*, based on her visits to the EfS website during the follow-up period: "[my understanding changed as] I have now a more sensitive perspective, towards the luchecillo and its positive aspects" (Julia, follow-up survey, *seq.* 457).

In addition, two mentions were made involving a *transformative change in understanding* over Mapuche worldview issues:

- While reviewing the Mapuche worldview I realized that I had some wrong ideas about it; and after reviewing in detail the texts on the website, my conception changed. (Ramiro, follow-up survey, *seq.* 464.01)
- In that sense I also have made a revalorization of the Mapuche culture, which is a clear example of how to live in harmony with the natural environment. (Rafael, follow-up survey, *seq.* 466.02).

These examples of how the EfS website prompted revalorization of indigenous knowledge and perspectives over sustainability issues in the context of Lanalhue Lake, not only shows evidence of the potential of EfS websites for consideration of indigenous knowledge in EfS, (this being considered an important issue within the EfS field (Agrawal, 1995; Armstrong, 2005; Van Damme, 2004)), but also shows the potential of the EfS website to promote transformative and integrative thinking (i.e. ecological thinking) between different dimensions involved with sustainability issues, e.g. natural and socio-cultural dimensions at Lanalhue Lake.

And Pamela's answer, the fourth participant from Group 1 indicating a transformative understanding over *other issues* at Lanalhue Lake, highlights another key theoretical consideration underpinning EfS websites: to promote social networking and learning (Guldberg, 2009; Krasny, 2010; Tilbury & Wortman, 2008; Webler et al., 1995). In this case, as stated by Pamela, the website assisted her to get to know local initiatives towards the local environment that she thought did not exist at all, motivating her to participate in environmental initiatives in the future:

> Before knowing the website, personally you do not know what is going on in regard to what are other people doing for the environment, so my perception has changed when you say 'how come nobody does anything to help?' when you see the deterioration or death of something related to the environment; now

> I can say that there are people doing something, which motivates me to participate and be a positive part of it.
>
> (Pamela, follow-up survey, *seq.* 459)

The underlying concept here is that by making visible similar local and/or global experiences and examples regarding sustainability issues, which can be regarded as a type of social networking, learners can go through a knowledge integration process and achieve a 'big picture' (i.e. holistic view) of sustainability issues (i.e. instead of just building understanding over a particular sustainability issue alone) (Linn et al., 2003; Nicolaou et al., 2009; Schweitzer et al., 2008). In fact, one of the purposes of revisits to the EfS website by Pamela was to accomplish social networking, as reported earlier (see Section 6.4): "I also re-visited the website to get to know and contact other local groups or websites related to caring for the environment, and so be up to date with what is going on" (Pamela, follow-up survey, *seq.* 428.02).

Finally, two participants scored under the last recurrent subtheme from Table 7.9, 'better understanding re sustainable living' (*theme code* 21.065), Rafael (Group 1) and Marisol (Group 2). This illustrates the significance of theoretical considerations related to promoting understanding not only over local sustainability issues, but also over general ecological sustainability and sustainable living, in terms of the underlying principles and ideas on which these concepts are based. For example, Rafael reported that to read about the concept of sustainability prompted him to reflect about it and the different ways of contributing to the lake's overall ecological sustainability:

> I've had heard the concept of sustainability before but never read about it. To know now the range of factors that have contributed and still are contributing to the sustainability issues on the lake has allowed me to think and value all the different ways there are to diminish the risks of the lake's ecosystem, and how to contribute towards its sustainability.
>
> (Rafael, follow-up survey, *seq.* 466.01)

Similarly, the EfS website promoted Marisol to achieve a *better understanding* of what the concept of sustainability involves, and how it can be related to the Lanalhue Lake context:

> [My understanding changed] in regard to sustainability, to environmental problems, to conserve our resources for the coming generations… And in regard to the social impact that sustainability issues have on our ecosystem.
>
> (Marisol, follow-up survey, *seq.* 461.01)

It must be noted that Marisol, who was categorised under typology Group 3 based on the pre-intervention typology, and then under typology Group 2 based on her post-intervention answers, included in her answer concepts that would fit a level of understanding proper of typology Group 1, demonstrating that she actually improved her understanding over sustainability issues at Lanalhue Lake, based on revisits to the EfS website. In fact, she is one of the participants coded under *acquired ecological perspective* in Table 7.9. In the coming section, new typology groups based on follow-up data may place her in a more advanced typology group.

7.4.2.1 Participants' follow-up level of understanding of sustainability issues

Follow-up typology groups can be determined based on findings from the follow-up phase, and on scores from the post-intervention typology groups. These follow-up typology groups help to determine participants' learning progression based on revisits to the EfS website, in terms of the *ecological literacy framework*. As mentioned before, systems thinking and ecological literacy are the two key concepts defining typology groups. Answers to questions Q2a and Q3a indicate that 5/18 participants, all from post-intervention typology Group 1, experienced a *transformative understanding* process during revisits to the EfS website; and that 6/18 participants (5 participants from post-intervention typology Group 2; and Emilio from post-intervention Group 1), acquired an *ecological perspective.* These findings support previous findings regarding *ecological*

perspective being more prone to occur within participants with a *mid* level of understanding of sustainability issues (Group 2), compared to participants with a *low* level.

Similar to previous typology groups (pre-intervention and post-intervention), follow-up typology groups were established following the following scoring system: participants scored under level-3 subthemes *transformative understanding* (*theme code* 21.060) and *acquired ecological perspective* (*theme code* 21.070), which are the subthemes involving progression in terms of ecological literacy and systems thinking, were given 3 points. For participants not scoring under these subthemes, no points were given. Table 7.10 presents follow-up typology groups related to new *levels of understanding* of sustainability issues after participants' revisits to the EfS website during the follow-up period.

Table 7.10. Follow-up typologies of participants regarding their level of understanding of the sustainability issues, after revisits to the EfS website.

Participant (*)	**Transformative understanding**	**Ecological perspective**	**New score**	**Group** (n)
Doris (11)	3	-	14	**1** (13) Score ≥ 8
Ramiro (10)	3	-	13	
Romina (12)	-	-	12	
Pamela (8)	3	-	11	
Rafael (8)	3	-	11	
Emilio (8)	-	3	11	
Julia (8)	3	-	11	
Pablo (7)	-	3	10	
Mateo (6)	-	3	9	
Manuel (8)	-	-	8	
Javiera (5)	-	3	8	

Participant (*)	**Transformative understanding**	**Ecological perspective**	**New score**	**Group** (n)
Javier (5)	-	3	8	
Marisol (5)	-	3	8	
Mario (6)	-	-	6	**2** (1) Score = 5-7
Oscar (4)	-	-	4	**3** (4) Score ≤ 4
Ana (3)	-	-	3	
Maria (3)	-	-	3	
Marcelo (2)	-	-	2	
Totals	**5**	**6**	-	-

(*) Post-intervention score. Note that scoring is based on the *ecological literacy framework*, and against level-3 subthemes under level-2 subtheme *change in understanding* (*theme code* 21.05; n = 18).

Findings from Table 7.10 provide evidence of the capacity of the EfS website to promote *transformative understanding* and *acquisition of ecological literacy* within participants, based on revisits. In comparison with post-intervention typology where only two participants indicated acquisition of *ecological perspective* after the first visit, changes over time prompted by the website related to ecological perspective (n = 6) are better seen after many visits. This is probably because the follow-up period provided better opportunities for participants to process change in understanding.

As well, the website offers a great amount of information to cover that potentially could change understanding on participants. In addition, comparing with post-intervention typology groups where *transformative understanding* processes occurred in participants with a *low* level of understanding (Group 3), in the case of follow-up typology groups such a

type of change in understanding occurred exclusively in participants with a *high* level of understanding (Group 1). This indicates that, overall, the website provided meaningful affordances for participants with different levels of understanding of sustainability issues. In particular, the website almost doubled the number of participants with a *high* level of understanding of sustainability issues (Group 1), from seven (pre-intervention) to thirteen (follow-up period). Therefore, it can be concluded that the EfS website was able to increase the ecological literacy of this cohort of participants.

7.4.3 Summary

As a summary of findings regarding change in understanding of sustainability issues at Lanalhue Lake *over time*, based on revisits to the EfS website during the follow-up period, it can be said that the EfS website prompted *change in understanding* towards Lanalhue Lake's sustainability issues in the majority of participants, and across all three typology groups. In both cases evaluated in this section, i.e. change in understanding over the *luchecillo* and over *other issues* related to sustainability issues at Lanalhue Lake, the type of change in understanding categorised as *better understanding* occurred across all three typology groups, being the most recurrent type of change overall. This suggests that the EfS website was able to promote a better understanding of sustainability issues at Lanalhue Lake among different participants, regardless of their typology group.

However, types of change in understanding defined as *acquired ecological perspective,* or as *transformative understanding*, in both cases (i.e. regarding the *luchecillo*, and regarding *other issues)* participants scoring under these types tended to come from a same typology group: *acquired ecological perspective* occurred almost exclusively within participants with a *mid* level of understanding (Group 2), supporting previous findings (Section 7.3.3); and *transformative understanding* occurred exclusively within participants with a *high* level of understanding (Group 1). This last means that participants already exhibiting ecological thinking and *high* levels of understanding of sustainability issues at Lanalhue Lake were also

able to go through a *transformative understanding* processes based on revisits to the EfS website. These findings, overall, indicate that affordances offered by the EfS website were meaningful to the majority of participants prompting understanding changes, but in different ways, depending on previous background, i.e. including typology groups, and on individual learning needs.

In addition, some isolated findings that need to be highlighted from this section are that the EfS website promoted some key EfS outcomes for some participants, like: critical thinking; learning about indigenous knowledge; integrative thinking (to achieve a 'big picture'); and learning about particular and general issues related to local and non-local sustainability, *over time*. All these concepts are considered important components of EfS interventions within the EfS field, and for the development of EfS websites at the community level

7.5 Summary

As a summary of Chapter 7 dealing with the ability of the EfS website to promote and improve participants' levels of understanding of socio-ecological sustainability issues at Lanalhue Lake, some key findings are here highlighted. Firstly, based on data from the pre-intervention questionnaire regarding participants' prior levels of understanding and knowledge regarding sustainability issues at Lanalhue Lake, it was possible in Section 7.2 to establish three different typologies of participants, in relation to their pre-intervention levels of ecological literacy over Lanalhue Lake's issues. These pre-intervention typology groups categorised participants into a *high, medium,* or *low* level of understanding and of ecological literacy for Lanalhue Lake's sustainability issues, permitting further comparison between participants and between typology groups after the intervention.

Analysis in Section 7.3, with the pre-intervention typology groups, showed that the website was able to prompt learning, understanding, and motivation/interest over Lanalhue Lake's sustainability issues within the

great majority of participants, and across all typology groups. This suggested again, as in Chapter 5, that the EfS website was meaningful to participants; and from an activity theory perspective, that the EfS website presented good potential to promote understanding based on interest and motivation in issues stimulated by the website. In particular, findings indicated that the majority of participants improved their understanding of sustainability issues at Lanalhue Lake, based on their first visits to the EfS website, with evidence indicating some trends regarding the type of change in understanding involved depending on typology groups, in some cases.

That is, change to achieving a *deeper understanding*, and to *reinforce prior knowledge* tended to occur within participants presenting a *mid* to *high* level of prior understanding, i.e. participants from Group 1 and Group 2. Whereas the type of change in understanding related to *thinking shift*, like recurrent subthemes *new perspective towards issues*, *transformative understanding*, and *acquired ecological perspective*, rather tended to occur within participants presenting a prior *mid* to *low* level of understanding of sustainability issues, i.e. participants from Group 2 and Group 3. These findings were possibly explained by the view that participants from the *higher end* of typology groups already possessed some degree of ecological thinking, thus being more prone to achieve a *deeper understanding* over a *thinking shift* type of change in understanding over sustainability issues, after the first visit to the website; and vice versa in the case of participants from the *lower end* of typology groups.

In regard to change in understanding evaluated *over time*, i.e. during the follow-up period of this study, Section 7.4 addressed this point both by assessing change in understanding over issues related to the *luchecillo* (i.e. eutrophication of the lake, the main topic addressed in the website), and over *other issues* at Lanalhue Lake, not necessarily related to the luchecillo. Findings here were similar to the ones based on the first visit to the EfS website, in that the great majority of participants presented a

change over time, in general (i.e. subtheme ‘better understanding’), and across all typology groups.

However, when focusing on the different types of change tending to occur within some of the participants from different typology groups (post-intervention typology), some trends appeared when comparing participants from the *higher* end versus the *lower end* of typology groups. In both cases, i.e. regarding the *luchecillo* and *other issues*, type of change in understanding defined as ‘acquired ecological perspective’ was seen occurring in participants from Group 2, similar to findings based on the first visit only. But participants from the *higher* end of typology groups (exclusively participants from Group 1), did present types of change in understanding defined as *transformative understanding*, in opposition to what would had been expected based on prior findings from Section 7.3, where ‘transformative understanding’ types of change in understanding were rather linked to the *lower end* of typology groups.

This suggested that the EfS website was able to promote types of change in understanding *over time* related to *transformative understanding* in participants who presented high levels of understanding of sustainability issues at Lanalhue Lake, and who were not expected to do so, based on findings from participants’ first visit to the EfS website (Section 7.3), where such a type of change in understanding did not occur within Group 1.

It must be pointed out that the change *over time* data represents participants freely revisiting the EfS website more than once and away from the researcher’s control, but from their normal place of access to the Internet, and following individual needs. This highlights the capacity of the website to improve understanding within a wide range of community members, i.e. presenting different backgrounds, prior conceptions, and needs. Such output comes from the theoretical consideration of addressing the target audience as a broad audience, demanding a wide range in variety, intensity, and sophistication of affordances.

Finally, other key findings from this chapter not necessarily directly related to types of change in understanding, but to EfS pedagogical considerations, are that the website promoted, in some cases, *critical thinking*, *integrative thinking* (i.e. to achieve a 'big picture' of sustainability issues), *indigenous knowledge* EfS (i.e. highly meaningful in the context of Lanalhue Lake; see Chapter 6), and knowledge over *local* and *global* sustainability issues, all these being key pedagogical considerations from the theoretical model to develop EfS websites. As argued earlier in Chapter 6, such qualities of the EfS website illustrated in this chapter support the idea of the EfS website being and acting as an EfS leader and facilitator of socio-ecological sustainability, from a complexity in education point of view.

Overall, and in conclusion for this chapter, it can be said that the EfS website *did* promote change in understanding over Lanalhue Lake's issues in the majority of participants, both after participants' first visit to the website, and over time, i.e. during the follow-up period. As well, the EfS website was able to *increase* the level of ecological thinking of participants as a cohort, indicated by typology groups starting with seven participants in Group 1 (pre-intervention typology), and finishing with thirteen participants in Group 1 (follow-up typology). This answers the research question in regard to the ability of the EfS website to promote understanding over sustainability issues among community members, in the context of Lanalhue Lake. In the next chapter, the last research question is addressed, i.e. the ability of the EfS website to promote *action* towards socio-ecological sustainability, and towards sustainable living among local community members.

CHAPTER 8 - ACTION FOR SUSTAINABLE LIVING AT LANALHUE LAKE

8.1 Introduction

As highlighted throughout this thesis, the two key EfS concepts underpinning the present research are *understanding* and *action*. This is, the ability of individuals to understand the relations between social and ecological dimensions of sustainability issues; and to act upon them by addressing solutions and root causes, and by considering consequences existing within the broader natural and social environments. These two concepts are evaluated here in relation to the potential of EfS websites in general, as culturally shaped ICT tools, to promote such *understanding* and *action* at the community level, in this case in the context of the sustainability of Lanalhue Lake in Chile. Before engaging with action-related findings, some clarification and definitions regarding this key EfS concept are reviewed in order to establish the theoretical framework underpinning this chapter.

The concept of *action* is taken here as introduced during the 1990s by researchers from the Royal Danish School of Educational Studies. In 1997, Jensen and Schnack defined the concept of action competence (AC) as an approach that would contribute to achieve one of the overall objectives of EfS: to build learners' ability to act in regard to existing and future sustainability issues and concerns (Jensen & Schnack, 1997). Literature states that development of action competence is at the basis of being an ecologically literate individual, and is an effective educational approach that contributes to real improvement of the natural environment, therefore being key to socio-ecological sustainability (Bolstad, 2003; Daudi, 2008; Huckle & Sterling, 1996; Jensen & Schnack, 1997; Orr, 1992, 2004; Sipos, Battisti & Grimm, 2008). In addition, one important value of this pedagogical approach to achieve EfS goals is that it engages learners with critical thinking, real-life issues, and holistic thinking, as learners are prompted to make links with other interrelated dimensions

when evaluating a particular sustainability issue (Räthzel & Uzzell, 2009; Uzzell, 1999).

Below are four key concepts from the action competence literature in EfS that underpin the Action Competence framework guiding the present chapter:

- Actions must be intentional, conscious, and targeted; they must address solutions of root causes of sustainability issues (Jensen & Schnack, 1997).
- Learners must understand *why* and for *what purpose* they engage with a particular action; actions involve motives and reasons (Jensen, 2002; Palmer, 1995).
- Actions can be direct or indirect: in the first case actions directly solve sustainability issues; in the second case actions influence others to contribute to solve sustainability issues (Jensen & Schnack, 1997).
- Actions differ from *activities* in that activities for sustainability do not necessarily target the underlying causes of a sustainability issue (e.g. rubbish cleaning) (Jensen & Schnack, 1997).

The two first concepts are the foundation of the Action Competence framework guiding this chapter: actions related to socio-ecological sustainability issues must be intentional and targeted (to root causes); and learners must understand the purpose and consequences of their actions, which in turn can be guided by motives and/or reasons. On the other hand, the two last concepts are rather considered as guidelines instead of core concepts of the Action Competence framework. Jensen and Schnack (1997) made the differentiation between *direct* and *indirect* actions, i.e. in relation to actions that directly solve sustainability issues versus actions that indirectly do so; and regarding *actions* versus *activities*, i.e. in relation to targeting root causes of sustainability issues or not. Although these distinctions are useful to categorise different types of actions in certain contexts, *actions* evaluated in the present study only occasionally included the level of detail in order to differentiate them in those terms. Similarly,

because the goal of the EfS website is to promote socio-ecological sustainability *and* sustainable living at the community level, in many cases depending on the perspective, the same action could be seen as direct or indirect, and as an activity instead of an action, whether associated to socio-ecological sustainability and/or to sustainable living.

For example 'education': to educate friends or family about local sustainability issues in the context of Lanalhue Lake, under the definition from Jensen & Schnack (1997), could be taken as an *activity* or an *action*, depending if such education is focussed on addressing root causes (directly or indirectly), or just to educate about the symptoms of sustainability issues. Or when considered from the perspective of achieving sustainable living at the community level, 'education' could be taken as a direct *action* if addressing the root causes of unsustainable living or not, as to live sustainably people need to be empowered in doing so, which can be achieved through education.

The key point is that actions must somehow contribute to achieving socio-ecological sustainability at Lanalhue Lake. In addition to this, any action carried out towards the socio-ecological sustainability of Lanalhue Lake is in turn defined by its socio-cultural context, by the historicity and uniqueness of such socio-cultural context, and by the objects, tools and outcomes underlying such action, as defined by activity theory.

The above criteria regarding *action* for sustainability defines the Action Competence framework to be used in the present chapter. This Action Competence framework allows contextualization of sustainability-related actions carried out prior and/or after participants' first visit to the EfS website lanalhuesustentable.cl. The aim of the present chapter, thus, is to assess if the EfS website was able to promote *actions* towards sustainability in the context of Lanalhue Lake in Chile, based on guidelines from the Action Competence framework. Note that as the ability to carry out action for sustainability is closely linked to the concept of ecological literacy, typology groups related to participants' levels of understanding

and ecological literacy used in Chapter 7 are also used in the present chapter. In the next section, participants' actions towards the sustainability of Lanalhue Lake, prior to their first visit to the EfS website, are explored and evaluated in order to assess the impact of the EfS website on participants in relation to promote their motivations and ability to carry out *actions*.

The coming sections of this chapter present findings related to participants' actions carried out based on visits to the EfS wesbite *Lanalhue Sustentable*. Section 8.2 firstly presents participants' reported pre-intervention actions towards the ecological sustainability of Lanalhue Lake, where actions prior the intervention are explored. Then Section 8.3 follows with presentation of findings regarding participants' motivation to take action prompted by the EfS website; and finally Section 8.4 presents participants' reported actions and adoption of sustainable living principles, based on revisits during the follow-up period. Section 8.5 at the end summarizes key findings and issues from this chapter.

8.2 Participants' pre-intervention actions towards the ecological sustainability of Lanalhue Lake

This section presents findings from the pre-intervention questionnaire (i.e. phase 4a) regarding *actions* towards the sustainability of Lanalhue Lake that some of the participants had done prior to this study's intervention; and the reasons and impediments experienced by participants who reported not having carried out actions. The overview of impediments, and actions carried out by participants before their first visit, permit later (Section 8.3) comparison with motivations to carry out actions expressed by participants during the post-intervention interview (phase 4c), immediately after their first visit to the EfS website; and with actual actions that were prompted by the use of the EfS website during the follow-up period (Section 8.4).

Three questions from the pre-intervention questionnaire aimed to assess if participants had carried out actions towards the sustainability of Lanalhue

Lake, prior to their first visit to the EfS website, and the associated reasons and/or impediments:

- Q13. Have you ever done anything to help the environment of Lanalhue Lake?
- Q13a. If *Yes*, what have you done and why?
- Q13b. If *No*, has anything prevented you from doing things to help?

The first question was a closed question looking to explore if participants had done anything towards the sustainability of Lanalhue Lake, with '*yes'*, '*no'* and '*I don't know'* as possible answers. Based on answers from question Q13, question Q13a evaluated what sort of actions participants had done, and why; and question Q13b, on the other hand, explored possible impediments to not having carried out actions prior to the intervention. Findings from this set of questions are presented below.

8.2.1 Participants' pre-intervention actions towards Lanalhue Lake

Participants' answers to question Q13, dealing with prior actions towards the sustainability of Lanalhue Lake, indicate the following:

- 15/24 participants answered '*yes'*, meaning that they had done 'things' or actions towards the sustainability of Lanalhue Lake prior the intervention;
- 7/24 participants answered '*no'*, indicating that they had not done actions towards the sustainability of Lanalhue Lake prior the intervention;
- 2/24 participants (i.e. Doris (Group 1) and Benjamin (Group 2)) answered '*I don't know*', reporting that they were unsure whether they had done anything towards the sustainability of Lanalhue Lake, prior to the intervention.

The above figures indicate that more than half of participants (n = 15/24) reported having done something towards the sustainability of the lake, prior to their first visit to the EfS website. When evaluated against pre-intervention typology groups (see Section 7.2), data shows that the number of participants reporting having done something towards the lake is equally distributed among groups, i.e. n = 5 participants per group.

However, distribution of participants that answered '*no*' to question Q13, i.e. meaning that they had not done something towards the sustainability of the lake prior the intervention, tended to occur more within the *mid* to *low* end of typology groups. Participants that answered '*no*' or '*I don't know*' show the following:

- 1/7 participant from Group 1 (i.e. Pamela) answered '*no*';
- 2/8 participants from Group 2 (i.e. Mario and Nora) answered '*no*';
- 4/9 participants from Group 3 (i.e. Mariana, Maria, Marisol and Marcelo) answered '*no*';
- 1/7 participant from Group 1 (i.e. Doris) answered '*I don't know*';
- 1/8 participant from Group 2 (i.e. Benjamin) answered '*I don't know*'.

Focusing on the 15/24 participants that answered '*yes*' to question Q13 of the pre-intervention questionnaire, answers to question Q13a dealing with the type of actions carried out by those participants prior the intervention, and their reasons, indicate the presence of five level-2 subthemes, and of nine level-3 subthemes. These subthemes were analyzed using theme code 13.00 'Actions carried out towards the ecological sustainability of Lanalhue lake, prior to first visit to the EfS website' of the Codebook. Table 8.1 presents these subthemes, with an indication of the number of participants from each pre-intervention typology group scoring under level-2 and level-3 subthemes. Note that each level-2 subtheme also refers to a main reason given as to why the participant carried out such a type of action, e.g. level-2 subtheme 13.05 'environmental care' means that actions under this category had as a main purpose to care for the environment of Lanalhue Lake.

Data from Table 8.1 indicates that, in general, there seems to be no clear correlation between typology groups and the type of actions carried out prior to the intervention, as answers are scattered across all three groups. However, for the most recurrent level-2 subtheme, i.e. subtheme 'Environmental care' (*theme code* 13.05), a tendency towards the mid-to-low end of typology groups (Group 2 and Group 3) can be seen when

merging both groups: 8/9 answers for this subtheme correspond to participants from Group 2 and Group 3, and only one answer, i.e. from Rafael who lived by the lake, was from Group 1.

Table 8.1. Participants' reported pre-intervention actions (n = 15, *theme code* 13.00). Note that some participants were scored more than once under level 3 subtheme.

Subtheme (Level 2 & 3)	**Group 1** (n = 5)	**Group 2** (n = 5)	**Group 3** (n = 5)	**Totals***	
				L3	**L2**
13.05 Environmental care	-	3	1	**4**	**8**
Rubbish and littering cleaning	1	-	2	**3**	
Luchecillo cleaning	-	1	-	**1**	
Asking people not to litter	-	-	1	**1**	
13.20 Education	1	-	-	**1**	**4**
Education at family level	-	1	1	**2**	
Education at community level	1	-	-	**1**	
Outdoor education	1	-	-	**1**	
13.10 Communication & discussion	3	-	-	**3**	**4**
Talk about issues with friends	-	1	-	**1**	
13.15 Work-based actions	-	-	1	**1**	**3**
Set projects with local authorities	1	-	1	**2**	
13.25 Sustainable living / principles	-	-	-	**-**	**1**
Organic recycling and composting	-	1	-	**1**	
Totals (n° coded responses)	**8**	**7**	**7**	**22**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme (some may have indicated more than one level 3 option).

As an overall overview of participants' reported pre-intervention actions prior to their first visit to the EfS website, it appears that all level-2 and level-3 actions from Table 8.1 could meet the criteria from the Action Competence framework, and thus be considered actions that contribute to the socio-ecological sustainability at Lanalhue Lake.

However, because those actions were made prior to the intervention and outside the scope and control of the present study, it is impossible to assert if participants were consciously targeting, with a sound understanding and purpose, the root causes of sustainability issues. Nonetheless, at this stage, what is important to highlight is the fact that some participants were reporting already carrying out actions that contributed to the socio-ecological sustainability of Lanalhue Lake.

One important answer from Table 8.1 to highlight is the one from Emilio (pre-intervention Group 2), who was the only participant that reported having carried out sustainable living related actions, which are not directly linked to the sustainability of the lake, but rather related to living sustainably at home. Emilio reported organic recycling and composting.

8.2.2 Participants' pre-intervention impediments and reasons not to carry actions towards Lanalhue Lake sustainability

All nine participants that indicated either '*no*' (n = 7/9) or '*I don't know*' (n = 2/9) in question Q13 (dealing with prior actions carried out towards the sustainability of Lanalhue Lake) answered question Q13b: 'If *No*, has anything prevented you from doing things to help?'. Two level-2 subthemes were identified from these 9/24 participants, which were coded using theme code 14.00 'Reasons and impediments not to carry out actions towards the ecological sustainability of Lanalhue Lake' of the Codebook. Table 8.2 presents these two subthemes, with an indication of the number of participants from each pre-intervention typology group scoring under each subtheme.

Table 8.2. Participants' reported reasons and impediments not to carry out actions towards the ecological sustainability of Lanalhue Lake, prior to their first visit to the EfS website (n = 9, *theme code* 14.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 2)	**Group 2** (n = 3)	**Group 3** (n = 4)	**Totals***	
				L3	**L2**
14.10 Reasons and impediments	-	-	-	**-**	**8**
Lack of knowledge of current activities underway	-	1	1	**2**	
Others' responsibility to carry action	1	1	-	**2**	
No real impediments	-	-	1	**1**	
Lack of time	-	-	1	**1**	
Lack of environmental concern	-	-	1	**1**	
No particular reason, just passivity in taking action	-	1	-	**1**	
Don't visit the lake	-	-	1	**1**	
14.05 Insufficient action done	-	-	-	**-**	**2**
Information outreach, but aware that is insufficient action	1	-	-	**1**	
Luchecillo cleaning, but aware that is insufficient action	1	-	-	**1**	
Totals (n° coded responses)	**3**	**3**	**5**	**11**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme. Note that some participants may have been scored under more than one level 3 subtheme.

The most recurrent level-2 subtheme, with 8/9 participants scoring, was subtheme 'Reasons and impediments' (*theme code* 14.10), including

seven level-3 subthemes. Three of these subthemes appeared to be actual impediments (i.e. ‘lack of knowledge of current activities underway’; ‘lack of time’; and ‘lack of environmental concern’); whereas the remaining four subthemes rather appeared to be related to reasons linked to passivity to carry out actions instead of actual impediments (i.e. ‘others’ responsibility to carry out action’; ‘no real impediments’; ‘no real reason, just passivity in taking action’; and ‘don’t visit the lake’). The majority of participants that reported impediments and/or reasons to carry out actions were from pre-intervention typology groups Group 2 and Group 3, i.e. Pamela was the only participant from Group 1 having scored under this level-2 subtheme. Answers from these participants were mostly short sentences, with answers being similar to the headings of the corresponding level-3 subthemes.

The other level-2 subtheme identified from participants’ answers to question Q13b was ‘Insufficient action done’ (*theme code* 14.05), under which Pamela and Doris (both from Group 1) scored. This subtheme means that these participants did carry out actions towards the sustainability of Lanalhue Lake, but considered them as being ‘insufficient’. Pamela stated that she had participated in the cleaning of luchecillo but knew it was not a significant action, and argued that it was others’ responsibility to take action for the sustainability of the lake: “Although I have helped to clean the lake of luchecillo, this help has not been significant. To solve these problems [sustainability issues] is responsibility of those who live by or frequently visit the lake” (Pamela, pre-intervention questionnaire, *seq.* 172.01). Similarly, Doris reported having carried out information outreach about the lake as part of her job (she worked at one of the local councils), but stated that she knew such action was insufficient: “As part of my work I have distributed material regarding the care of the lake, but at this stage I consider that to be insufficient” (Doris, pre-intervention questionnaire, *seq.* 168).

The key point to highlight here is that Pamela and Doris, both from Group 1, had carried out actions towards the sustainability of the lake prior to the

intervention, but they both considered that such actions were insufficient, and thus, preferred to answer '*no*' in question Q13. This finding, combined with findings from Section 8.2.1 where 7/17 participants from typology groups Group 2 and Group 3 reported not having carried out actions towards the sustainability of the lake prior the intervention (or being unsure about it in the case of Benjamin from Group 2), supports the notion that participants from Group 1, with a *high* understanding of sustainability issues, were more prone to have carried out some action towards the sustainability of Lanalhue Lake, when compared to participants from the two other typology groups. In fact, by combining findings from Table 8.1 and 8.2, all participants from Group 1 had carried out actions towards the lake, prior to the intervention, compared to just 10/17 participants from Group 2 and Group 3 that carried out actions prior the intervention.

From an activity theory and Action Competence framework point of view, this can be interpreted based on the view that to carry out an action for sustainability (i.e. or an 'activity' when using activity theory terminology), learners must have motivations. Activity theory states that motivations are at the basis of activities; and the Action Competence framework defines an *action for sustainability* as involving motives and reasons, based on sound understanding. Therefore, participants with higher ecological literacy, as is the case for participants from typology Group 1, were more likely to have carried out actions for the sustainability of the lake prior the intervention of this study, based on reasons, motives, and motivation, which in turn are based on meaningfulness towards local issues.

8.2.3 Summary

The objective of this section was to indicate if participants had carried out actions towards the sustainability of Lanalhue Lake prior to the intervention of this study; and if not, what were the reasons and impediments. It seemed that the higher the ecological literacy level from participants regarding sustainability issues at Lanalhue Lake, represented by pre-intervention typology groups defined in Chapter 7, the more likely it was that they had carried out actions towards the lake, prior to the

intervention. Other findings from this section could be highlighted here, however, at this stage, the key finding presented above is the one to keep in mind until the coming sections are examined.

In the next section, findings from the post-intervention interview related to motivations to take action, and to live sustainably, based on participants' first experience with the EfS website lanalhuesustentable.cl are discussed.

8.3 Participants' motivation to take action prompted by the EfS website

During the intervention phase, the 24 participants were presented the EfS website lanalhuesustentable.cl for the first time, and were invited to browse it for up to 20 minutes, depending on participants' time availability. Immediately after the intervention, participants were interviewed to evaluate their perceptions of the website, change in understanding regarding sustainability issues at Lanalhue Lake, and motivation to take action towards the sustainability of the lake, and/or to adopt sustainable living principles, prompted by the EfS website. In this section, findings regarding participants' motivation to take action towards the sustainability of Lanalhue Lake and/or to adopt sustainable living principles are presented.

The questions from the post-intervention interview dealing with participants' motivation to carry out actions towards Lanalhue Lake were the following:

- Q7. Has using this website motivated you to do something to address the environmental / sustainability issues present at Lanalhue Lake? If so what specifically? Why/why not?
- Q7b. Do you think there is something that can be done to contribute towards the sustainability of Lanalhue Lake?
- Q8. Has using this website changed your thinking about whether you are living in a sustainable way? Why/why not?

Question Q7 assessed participants' possible new motivation to carry out actions towards the socio-ecological sustainability of Lanalhue Lake, after using the EfS website for the first time; whereas question Q7b rather asked participants if there was something that they thought could be done towards the sustainability of the lake, without explicitly asking about new motivations from the use of the EfS website. Question Q8, on the other hand, invited participants to reflect on whether they live in a sustainable way or not, prompting them to provide input about it. Note that in some cases data may have come from follow-up questions that were asked of some participants.

8.3.1 Participants' motivation to take action

Due to interview logistics (e.g. time constraints, or *direction* of the interview based on answers), of the 24 participants taking part in the intervention, 21 were asked question Q7 dealing with new motivations prompted by the EfS website; 6 participants were asked both questions Q7 and Q7b; and 3 participants, i.e. Doris (G1), Mario (G2) and Julia (G2), were only asked question Q7b dealing with possible actions that could be done. This means that 21/24 participants were explicitly asked if the EfS website prompted them to take action towards the sustainability of Lanalhue Lake. Data from answers to question Q7 indicate that:

- 19/21 participants reported a motivation to take action prompted by the use of the EfS website;
- Rosario (post-intervention Group 3) and Mateo (post-intervention Group 2) reported no motivation to take action, both arguing 'lack of time' (*theme code* 14.160).

Answers from the 3/24 participants that only were asked question Q7b indicate that:

- Doris and Julia (both from post-intervention Group 1) also reported motivation to take action from the use of the EfS website;
- Mario (post-intervention Group 2) reported that things could be done to contribute towards the sustainability of the lake, and that

such actions should come from authorities, experts, and the community (*theme code* 12.355).

Regarding the 21/24 participants who indicated a motivation to carry out actions towards the lake based on their first visit to the website, five level-3 subthemes were identified from answers to questions Q7 and Q7b, related to types of actions that participants reported being motivated to carry out. These subthemes were analyzed using theme code 17.00 'Motivation to take action, after the first visit to the EfS website' of the Codebook. Table 8.3 presents this data, with an indication of the number of participants from each post-intervention typology group scoring under level-3 subthemes.

Table 8.3. Participants' motivation to take action prompted by the EfS website (n = 21; *theme code* 17.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 9)	**Group 2** (n = 7)	**Group 3** (n = 5)	**Totals***	
				L3	**L2**
17.05 Motivation to take action	-	-	-	**-**	**21**
Motivation to take action / get involved	4	6	4	**14**	
Education related action	5	4	-	**9**	
Lake related action	2	1	1	**4**	
Community related action / participation	1	-	-	**1**	
Action at home / own business	-	-	1	**1**	
Totals (n° coded responses)	**12**	**11**	**6**	**29**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme. Note that groups are post-intervention typology groups; some participants were scored under more than one level 3 subtheme.

The most recurrent level-3 subtheme from Table 8.3, with 14/21 participants scoring, is 'motivation to take action / get involved' (*theme code* 17.075), this being a *general* type of action. Some participants here briefly answered 'yes, it motivates me' (e.g. Marcelo (Group 3) and Marisol (Group 2)), or 'yes, of course' (e.g. Pamela (Group 1), Rafael (Group 1), Javiera (Group 2), and Ana (Group 3)). Maria (Group 3) went further and indicated that, as a local person, she was worried and wanting to collaborate, but that as an individual she was not sure about the impact she could generate, highlighting the need for social organizations:

> [I have] a concern that we all should have, right? When you grow up close to the lake and you see the deterioration of the environment, obviously one wants to collaborate. Now, in which way? The simplest is by avoiding polluting. But I think this is a bigger issue, is not really about one person, what can an individual achieve? I think that by organising, through an organization for example, if there is any, a group could do it better, and one could maybe collaborate through them.
>
> (Maria, post-intervention interview, *seq.* 303.01)

In second place of recurrence is the subtheme 'education related action' (*theme code* 17.070), which, on the contrary to the most recurrent subtheme, tended to occur more in the higher end of post-intervention typology groups (i.e. Group 1 and Group 2). It is interesting to note how important the educational dimension appears for 9/21 participants, in that, education is considered by them as a key driver towards a more sustainable Lanalhue Lake. For example, Romina (Group 1; a teacher), stated that by educating her students she could reach their parents at home: "Yes [I am motivated], I can teach my students that are at my reach, so they can later educate their parents about it at home" (Romina, post-intervention interview, *seq.* 304). Or Rafael, also from post-intervention Group 1, who said that he could educate at the social level though communicating the issue, i.e. explain issues to friends, and even mentioned the idea of reporting misconducts like littering, as he saw it as an issue linked to the accelerated eutrophication of the lake:

> Yes [I am motivated], I mean, even in a conversation with a friend or whoever, I will be able now to explain things to them, and also communicate about existing options; or even maybe report people polluting and littering, which also is an issue causing the accelerated eutrophication of the lake.
>
> (Rafael, post-intervention interview, *seq.* 325.02)

The remaining level-3 subthemes from Table 8.3 are actions that some participants reported being motivated to carry out, i.e. actions at the lake level (*theme code* 17.055), at the community level (*theme code* 17.065), and at the business level (*theme code* 17.080), with no particular trends towards a typology group, in part probably due to low numbers. One example of motivated actions at the lake level is the one reported by Emilio (post-intervention Group 1), who stated: “Yes definitely [I am motivated]! I have 2 kilometres of the lake’s shore. So whatever thing we can do, and that we can do altogether, adds up” (Emilio, post-intervention interview, *seq.* 315.02).

In regard to actions at the community level, Ernesto (post-intervention Group 1), who reported having participated in different initiatives related to the lake, wanted more concrete actions to happen:

> Yes, in fact I have participated in different initiatives, so I am interested in more concrete actions to happen. For example, I am a musician and I am willing and available to collaborate in any activity, from my perspective, from the music point of view. But I am also interested in voluntary work like cleaning the lake; and to get people aware and conscious that we have to care for our environment.
>
> (Ernesto, post-intervention interview, *seq.* 328)

And finally, one example regarding actions at the business level, Ana (post-intervention Group 3), who has an eco-tourism related business, stated the following:

> Yes of course [I am motivated], as I was saying, there are things I did not know about, and I think that this information, it's information that will help me to improve what I have, it's going to help me I think.
>
> (Ana, post-intervention interview, *seq*. 308.02)

Overall, the relevant finding from this section is that the EfS website stimulated *motivations* to take action by the majority of participants, from across all three typology groups, and at different levels, e.g. at the business, educational, or community action level. As reviewed in the introduction of this chapter, the Action Competence framework informing this chapter highlights that actions for sustainability not only need to be grounded in sound understanding from learners, but also driven by *motives* and *reasons*.

Similarly, in activity theory (AT) literature, an *activity* contains and is driven by, among other things, *motivations* for the subject to participate in such activity. These *motivations* are directed at a goal (i.e. the 'object' of the activity); mediated by a tool, in this case, the EfS website seen as an educational tool; and by other AT system's components, like the rules, division of labour, and historicity of the local community (Krasny & Roth, 2010; Yamagata-Lynch, 2007). This means that these *motivations* of participants prompted by the EfS website, at this stage, are indicators, and are situated at the core, of possible actions that the majority of them reported being willing and motivated to carry out in regard to the sustainability of Lanalhue Lake.

The data also indicates that, as expected from activity theory, the different types of motivated actions reported by many participants were directly related to their individual socio-cultural contexts and reality, making such motivations meaningful to them within their own milieu. This can be seen in the quotes provided above. For example, Ana (post-intervention Group 3), who reported a motivation to carry out sustainability related actions, said that such actions were going to be directed to her own tourism

business; or Ernesto (post-intervention Group 1), who as a musician was wanting to participate in community initiatives, but from the music point of view; or Emilio (post-intervention Group 1) who stated that he was responsible for 2 kilometres of the lake's shore, so his actions were going to be around the fact that he has a direct influence on his sector of the lake. This finding can be seen as the result of a key objective of the EfS website: to provide affordances in a way that would result in meaningful experiences for the broader audience of the target community; where each learner generates their unique experience from using the EfS website.

In the next section, findings regarding the capacity of the website to promote a sustainable way of life among participants are reviewed.

8.3.2 Participants' reflection about living sustainably

The EfS website's capacity to promote adoption of sustainable living principles among participants was evaluated through question Q8 of the post-intervention interview: 'Has using this website changed your thinking about whether you are living in a sustainable way? Why/why not?' This question invited participants to reflect on their current way of life in terms of living sustainably or not, and to provide insights regarding the role of the EfS website in promoting such reflective processes. Answers from 22/24 participants (i.e. Javiera and Javier from Group 2 did not answer question Q8) indicate that:

- 18/22 participants thought about living sustainably prompted by their visit to the EfS website;
- 3/22 participants did not think about living sustainably during the intervention; with Nora (post-intervention Group 2) reporting lack of time for it during the intervention;
- 1/22 participant, i.e. Pablo (post-intervention Group 2), had been thinking about living sustainably prior to the intervention, but the EfS website reinforced that process.

The above figures indicate then that the EfS website was able to promote a reflective process regarding sustainable living for the majority of

participants. Two examples of answers reporting such a reflective process are the ones from Maria (post-intervention Group 3), and Mateo (post-intervention Group 2). Maria noted that the EfS website invited her to reflect about her own situation in regard to living sustainably:

> Yes, yes, indeed, because I think that then you analyze yourself. 'What am I doing for the environment?' Because you talk about it, you hear many things, but in fact you do nothing about it. So yes I think it is an invitation [from the website]. From my daily living, let's say, what do I do to contribute to care for the environment?
>
> (Maria, post-intervention interview, *seq.* 350)

And Mateo, who earlier in Section 8.3.1 reported a 'lack of time' (*theme code* 14.160) to carry out actions, reported here that while he was visiting the EfS website he thought about what happened to the sewage water he produces at home, if it directly affects the eutrophication process of the lake or not; and about the Chilean attitudes to environmental awareness:

> Uhmm, yes, yes, because in fact I think that although we do live in a city [Contulmo] that apparently has everything, it is well organised, it is not actually like that at all. While I was reading [the website] I was wondering myself where does the used water from my house go, where does it all go? And wherever it goes, is it going to directly affect the lake, or any other natural resource? I also thought after that that the Chilean society has not much awareness regarding such [environmental] issues.
>
> (Mateo, post-intervention interview, *seq.* 371)

In addition, answers from 14/22 participants also provided some input regarding different aspects of living sustainably, like for example, input about motivations regarding learning more about sustainable living principles, or impediments that make adoption of such processes difficult. These answers were analyzed using theme code 18.00 'Participants' reflection about living sustainably, prompted by the EfS website' of the Codebook, and grouped under level-2 subtheme 'Reported aspects of living sustainably' (*theme code* 18.15), including eight level-3 subthemes.

Table 8.4 presents this data, with attention to categorisation by post-intervention typology groups.

Table 8.4. Participants' reflection about living sustainably, prompted by the EfS website (n = 14, *theme code* 18.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 4)	**Group 2** (n = 5)	**Group 3** (n = 5)	**Totals***	
				L3	**L2**
18.15 Reported aspect of living sustainably	-	-	-	**-**	**14**
Recognises that not living sustainably yet	2	1	1	**4**	
Adopting sustainable living principles prior the intervention	2	1	1	**4**	
Adoption of sustainable principles at home	1	1	1	**3**	
Motivation to learn more about sustainability	1	-	1	**2**	
Lack of knowledge / need of education	-	2	-	**2**	
Lack of means (e.g. recycling service)	-	1	-	**1**	
Avoid sewage waters into lake	1	-	-	**1**	
Consideration of Indigenous knowledge and practices	1	-	-	**1**	
Totals (n° coded responses)	**8**	**6**	**4**	**18**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme. Note that some participants were scored under more than one level 3 subtheme.

In general, data from Table 8.4 is dispersed by not having any subtheme with a concentration of participants scoring under it, and by being more or less equally distributed among typology groups. Only the subtheme 'lack of knowledge / need of education' (*theme code* 18.170) appears to be

more represented in a typology group, as the two participants who claim a *lack of knowledge* to adopt sustainable living principles are from post-intervention Group 2 (i.e. Soledad and Marisol). Soledad stated that she was unsure about certain things:

> Yes, as I was saying, one keeps learning, and sometimes you realise that one contradicts oneself, you think that sometimes you are doing things right, but in reality you don't really know if you are doing things right or wrong.
>
> (Soledad, post-intervention interview, *seq.* 368.01)

It can also be noted that the eight different level-3 subthemes identified from participants' answers, and presented in Table 8.4, involve quite different aspects; reflecting the many different issues that living sustainably involves for these 14/22 participants. For example, Pamela (post-intervention Group 1) was scored under subtheme 'adoption of sustainable principles at home' (*theme code* 18.155), where she reported a series of sustainable principles that she was considering to adopt as part of her daily routine, e.g. saving water:

> [You mean] to live in sustainable way? Ehm yes, especially in regard to avoid eating [genetically] modified food, or, for example, reduce the electricity consumption, because you can still live normally doing such things, like taking shorter showers. I know I take too long showers, because I think there is no awareness in regard to water, in other countries people need to ration their consumption, and you don't see that here, people use water as they like, wasting it unnecessarily.
>
> (Pamela, post-intervention interview, *seq.* 356.01)

Or Ernesto from Group 1, who in his answer highlighted the need to stop talking and start acting in regard to the environment; and that there was much to learn from the ancient indigenous knowledge from the local Mapuche culture:

> Yes, yes, because in first place everything related to the environment usually is treated in a very theoretical way that you

> don't take into practice. To me is very important to stop the chitchat and start doing things, and in that sense do things like, for example, recycle all the organics. In that sense here the Mapuches in the past everything that we consider waste they used, they reuse it; and today there are some groups recovering those ancient ways.
>
> (Ernesto, post-intervention interview, *seq.* 372.01)

In the case of Emilio (post-intervention Group 1), he reported that he was responsible for a sector of the lake, in the sense of having direct influence on it. In that regard, Emilio indicated that the EfS website prompted him into a reflective process in regard to his current practices on his land:

> Yes, definitely yes, one of the first things that came to my mind was precisely the treatment of sewage waters. Am I doing the correct thing? Am I not? Am I chopping [native bush]? Am I not chopping it? Am I burning things on my land? Yes, indeed I am. So definitely yes there are a bunch of questions about the way I do things, so you then think 'how do I act'? How do I mitigate my impact? Who can assist me with it to avoid doing unsustainable practices that go against the care of the environment?
>
> (Emilio, post-intervention interview, *seq.* 363.01)

And finally, Benjamin (post-intervention Group 2) reported that the website did prompt in him a reflective process regarding living sustainably, particularly regarding waste management at home, but that he felt that in many cases there was a lack of means to achieve such sustainable living, for example, lack of means from the local council in regard to a recycling service:

> I think that yes, but undoubtedly I could do a lot more. I try to keep things separated [waste], but there is a lack of means at the local council, because you can separate your waste at home, but then comes the waste truck and put them all back together, so then you think why even bother to separate them. But still you have to separate your waste, or avoid mixing it, like throwing away what is

> rubbish, avoiding spilling oils in the garden and keep it in a bin and get rid of it properly, at least it's a contribution.
>
> (Benjamin, post-intervention interview, *seq.* 360.01)

As a summary from this section, data indicates that the website was able to prompt a *reflective process* regarding the adoption of sustainable living principles in the majority of participants. In addition, input from participants indicated that different participants experienced this reflective process from their particular point of view, and referring to their individual real-life contexts. This last finding was expected from an activity theory perspective, in the sense of acknowledging that each participant brought into this reflective process, prompted by the EfS website, their own characteristics and needs, which in turn are linked to their individual historical and socio-cultural realities. In some cases, the reflective process was linked to the sustainability of the lake, like in the case of Emilio and his direct influence on a sector of the lake. The key point is that all those different perspectives were pointing towards the same direction: the adoption of sustainable living principles.

8.3.3 Summary

In this section, two key aspects of the EfS website were evaluated: firstly, the EfS website's capacity to promote *action* towards the socio-ecological sustainability of Lanalhue Lake; and second, the website's capacity to promote the adoption of sustainable living principles among participants. These two aspects of the website were evaluated based on data from the post-intervention interview, meaning that participants' answers were based on their first experience using the EfS website; and that input provided was in the form of *motivations* to take action, and/or to adopt sustainable living principles. In regard to the theoretical framework, in action competence (AC) and in activity theory (AT), motivations are seen as precursors of actions / activities, and act here as *indicators* of possible future *actions*.

Findings show that the EfS website was able to promote, within the majority of participants, both motivations to take action towards the sustainability of Lanalhue Lake, and motivations to adopt sustainable living principles. Findings also show that, as one would expect from activity theory, each participant developed a unique experience from the use of the website, based on individual backgrounds and contexts. This was reflected in the different types of motivated actions reported, and on the different perspectives regarding sustainable living indicated by participants. This highlights the importance for EfS websites to address the broad audience of target communities, in order to encourage meaningful responses to the various needs existing in a community.

Overall, these findings suggest that the EfS website was able to promote motivation for *action* towards Lanalhue Lake's sustainability and participants' sustainable living. This directly addresses the research question: if EfS websites can promote *action* towards sustainability. Whether the EfS website was able to promote action *over time*, is examined in the next section.

8.4 Participants' actions and adoption of sustainable living principles

This section addresses the EfS website's capacity to promote *action* towards the sustainability of Lanalhue Lake and the adoption of sustainable living principles *over time*. As mentioned earlier, EfS literature highlights that actions are what can bring about real and effective change in working to achieve sustainable societies, stressing the importance of developing action competence abilities and skills (Bolstad, 2003; Daudi, 2008; Huckle & Sterling, 1996; Jensen & Schnack, 1997; Orr, 1992, 2004). The capacity of the EfS website to promote action towards sustainability and adoption of sustainable living principles is a key aspect of the website to evaluate.

The follow-up phase of this study was characterised by an online survey applied to the 18/24 participants that replied to the researcher's invitation

to be part of this phase. This survey assessed the promotion of *action* and the adoption of sustainable living principles over time, through both quantitative and qualitative questions. In Section 8.4.1, quantitative data is presented regarding participants' reported actions carried out towards the sustainability of Lanalhue Lake during the follow-up phase, prompted by the EfS website. Here, data comes from a list of possible actions presented to participants, who had to indicate which ones they had carried out, based on their revisits to the website.

Next in Section 8.4.2 qualitative data regarding participants' adoption of sustainable living principles are presented, also based on revisits to the EfS website. This data provides insights into the type of sustainable principles adopted by participants, and the factor motivating such adoption, whenever that occurred. Finally, Section 8.4.3 summarises findings from this section. Note that in this section typology groups used correspond to the *follow-up typology* determined in Section 7.4.2 (see Table 7.10). This typology categorised participants' level of understanding of sustainability issues at Lanalhue Lake *after* their revisits to the website done during the follow-up period.

8.4.1 Participants' actions carried out during the follow-up period

In order to assess if the EfS website promoted action by participants, based on their revisits to the EfS website during the follow-up period, question Q6 of the follow-up survey asked participants: 'Have you done any of the following based on your visit(s) to the Lanalhue Sustentable website?'. This question presented participants a list of 11 possible actions grouped under three main themes: (1) website-related actions; (2) Lanalhue Lake-related actions; and (3) actions related to sustainable living at home.

Table 8.5 presents the list of actions from question Q6, and indicates the number of participants scoring under each option, categorised into typology groups. Because the numbers of participants allocated in each follow-up typology group are notably different (Group 1 = 13/18

participants; Group 2 = 1/18 participant, and Group 3 = 4/18 participants), comparison between typology groups at the group level did not always result in helpful data. Therefore, findings here are presented in a more general way, rather than comparing between typologies as before. Nonetheless, this also means that more than two thirds of participants of the follow-up phase end up with a *high* understanding of sustainability issues throughout their visits to the website. And that actions carried out by them were made from such a high level of understanding of sustainability issues, making those participants competent community members, from an *action competence point* of view.

Table 8.5. Participants' reported actions carried out during the follow-up period, based on revisits to the EfS website (n = 18). Typology groups correspond to follow-up typologies.

Actions	**Group 1** (n = 13)	**Group 2** (n = 1)	**Group 3** (n = 4)	**Total**
Website related actions				
Told a friend about the website	12	-	3	**15**
Visited links shown on the Lanalhue Lake website	9	1	3	**13**
Visited other websites on environmental issues	8	1	2	**11**
Visited the website's social networking sites (i.e. Facebook, Twitter, Flickr, YouTube)	2	-	2	**4**
Subtotal	***31***	***2***	***10***	***43***
Lake related actions				
Visited the lake	9	1	2	**12**
Thought about how you could help improve the lake's environment	10	-	2	**12**

Actions	Group 1 (n = 13)	Group 2 (n = 1)	Group 3 (n = 4)	Total
Taken any other direct action to help improve the lake's environment	9	1	-	**10**
Spoken or written to any authority about the environmental problem's in the lake	2	-	1	**3**
Subtotal	***30***	***2***	***5***	***37***
Immediate environment related actions				
Taken any direct action to help improve your immediate environment (e.g. at home)	9	-	2	**11**
Thought about how you could improve your immediate environment (e.g. at home)	9	-	1	**10**
Subtotal	***18***	***0***	***3***	***21***
Other actions *(please specify)*				
Deeper competence in EE / EfS (Romina)	1	0	0	**1**
Totals (n° coded responses)	**80**	**4**	**18**	**102**

In regard to website-related actions, 15/18 participants (from Group 1 and Group 3) 'told a friend about the website', this being the most recurrent action of all indicated by participants. The other recurrent website-related actions reported were 'visited links shown on the Lanalhue Lake website' (n = 13/18), 'visited other websites on environmental issues' (n = 11/18), and 'visited the website's social networking sites (i.e. Facebook, Twitter, Flickr, Youtube)' (n = 4; Pamela and Manuel from Group 1, and Ana and Marcelo from Group 3). Note that all *website-related actions* are actions

associated with *social networking* instances, whether face to face like in the first case, or through the EfS website, like in the other cases. Social networking is a key concept in the present study. Social interaction and networking are regarded as being at the basis of social learning, thus critical to community EfS (Davis & Sumara, 2005; Guldberg & Mackness, 2009; Krasny & Roth, 2010; Morrison, 2002; Tilbury & Wortman, 2008).

From a complexity in education theory perspective, *interactivity* and *means to affect each other*, are key elements of learning in self-nurturing educational systems (Davis & Sumara, 2005; Morrison, 2002), making social networking vital to the *learning process* in such systems. Based on these arguments, the promotion of *social networking* related actions, prompted by the EfS website, appears critical for the self-nurturing of the website itself, and for participants' associated learning processes.

Regarding *lake related actions*, the two most recurrent actions reported by participants were 'visited the lake', and 'thought about how to help improve the lake's environment', both with 12/18 participants from all typology groups. Then the third most recurrent action, with 10/18 participants reporting it, was 'taken any other direct action to help improve the lake's environment'. This option is the closest option to what would be a *direct* action towards the sustainability of the lake, in terms of Jensen and Schnack (1997), meaning *actions* that directly contribute to solve sustainability issues at Lanalhue Lake. Additionally, for this option there was a tendency towards *high* and *mid* levels of understanding of sustainability issues by those reporting (follow-up typology groups), with no participant from Group 3 reporting such action.

This could mean that participants with a *higher* level of understanding were more prone to carry out direct actions towards the sustainability of the lake, than participants with a *low* level of understanding (Group 3). Note that a similar finding was highlighted earlier in regard to pre-intervention actions reported by participants (Section 8.2.2). Or it could also mean that participants from Group 3 had less interest in taking action,

perhaps from having less emotional bonds towards the lake. My opinion as the researcher is that there is a bit of the latter in at least half of the four participants from the follow-up typology Group 3.

Note that because of the design of the follow-up survey (online survey), no further details of the *type* of actions taken by those 10 participants reporting so were obtained. It can be said though, according to reports from participants, that the EfS website appeared to promote *direct action* towards the sustainability of the lake in more than half of the follow-up participants, this occurring almost exclusively within Group 1 participants. This directly addresses the research question related to the capacity of the website to promote *action*.

Finally, regarding the least recurrent *lake-related* action, three participants reported having contacted authorities in regard to the sustainability of the lake: Manuel and Julia from Group 1, and Ana from Group 3. Note that this type of action illustrates a degree of *political literacy*, which was one of the components included during the design phase of the EfS website. As highlighted in Chapter 2, *political literacy* is the ability to meaningfully participate in democratic processes within a democratic society, based on understanding, critical thinking, and decision-making skills (Myers, 2005; Sterling, 2001, 2005; Tilbury & Wortman, 2008). Hence, actions like contacting local authorities to discuss sustainability issues of the lake appears to be an important outcome in EfS, which in this case was prompted by the EfS website for those participants.

In regard of the third main action theme from Table 8.5, i.e. *immediate environment related actions*, which were associated with sustainable living, both options were selected by 14/18 participants. The option ‘taken any direct action to help improve your immediate environment (e.g. at home)’ was selected by 11/18 participants, from Group 1 and Group 3. Whereas the option ‘thought about how you could improve your immediate environment (e.g. at home)’ was selected by 10/18 participants, also from Group 1 and Group 3. This finding indicates that the EfS website prompted

over half of the follow-up participants to take actions related to better living, by, in one way or another, improving their immediate environment. Finally, Romina, a secondary science teacher from Group 1, was the only participant to select the *other actions* option. Her other action was increased competence in environmental education, in order to contribute towards the ecological literacy of her students.

Overall, it can be suggested from this section that the EfS website appeared able to promote *action* towards the sustainability of the lake among the majority of participants from all three typology groups. Some reported actions were more *direct* than others, in terms of addressing root causes of sustainability issues, but as mentioned before, all actions evaluated contributed somehow to the general socio-ecological sustainability of the lake and of the local community. Whether by provoking social networking, sustainable living, or just visiting the lake and talking about it with friends, participants representing a range of backgrounds, needs and interests reported contributing to a better socio-ecological community at Lanalhue, prompted by the EfS website. In the next section, the capacity of the website to promote the adoption of *sustainable living* principles by participants is evaluated.

8.4.2 Participants' adoption of sustainable living principles

Participants' adoption of sustainable living principles and practices, based on revisits to the EfS website during the follow-up period, was assessed by means of the following questions from the follow-up survey (phase 4d; n = 18):

- Q7. Has visiting the *Lanalhue Sustentable* website prompted you to adopt any new sustainable living principles (e.g. recycling, care about the environment, etc.)? *Yes No Do not know* (Please circle one)
- *If No*:
- Q7a. Have you *considered*, or had the *intention*, to adopt any new sustainable principle in your life? *Yes No Do not know* (Please circle one)

- Q7b. Has anything prevented you from adopting sustainable living principles? *Please explain*
- *If Yes*:
- Q7c. What sustainable living principles have you adopted? *Please explain*
- Q7d. What has prompted you to make those changes? *Please explain*

Answers to question Q7 indicate that:

- 14/18 participants indicated *yes*, reporting adoption of sustainable living principles, prompted by the EfS website;
- 2/18 participants indicated *no*, reporting no adoption of sustainable living principles based on website revisits;
- 2/18 participants indicated *do not know*, reporting being unsure about the website prompting on them the adoption of sustainable living principles.

Data indicates that the EfS website promoted adoption of sustainable living principles in the majority of the follow-up participants; with only 2/18 participants reporting not doing so (Pamela and Javier, both from Group 1), and 2/18 indicating being unsure about it, i.e. Maria (Group 3) and Pablo (Group 1). Note that typology groups referred to here are related to the *follow-up typology* (see Section 7.4.2.1).

In regard to Pamela and Javier from Group 1 (follow-up typology), the two participants that indicated *not having adopted* sustainable living principles in question Q7, they both answered *yes* in question Q7a, meaning that they both had *considered* or had the *intention* to adopt sustainable living principles. Following question Q7a, their answers to question Q7b 'has anything prevented you from adopting sustainable living principles?' provided further details on this. In the case of Javier, the *time* factor (*theme code* 25.155) appears to be the impediment for him not to adopt sustainable living principles, although he recognised that he can (and maybe does) contribute towards the local sustainability by preferring some

transport options over others: “The time factor affects. I have always been of the opinion that to walk, or use alternative transport [i.e. public transport] is a good way to contribute towards the local sustainability” (Javier, follow-up survey, *seq.* 540).

In the case of Pamela, her reported impediment to adopt sustainable living principles, based on revisits to the EfS website, appears to be related to prior experiences with a local environmental group, where she already gained awareness about environmental care and about daily actions that contribute towards the environment. So adoption of sustainable living principles by her were not prompted by the EfS website, but linked to these prior experiences. As stated by her:

> Prior this [intervention], I have participated in an ecological group linked to different causes and websites related to the environment, through which I have been able to gain awareness regarding actions that can be made on a daily basis.
>
> (Pamela, follow-up survey, *seq.* 539)

Concerning the 14/18 participants who reported having adopted sustainable living principles prompted by the EfS website, 13/14 participants answered question Q7c ‘what sustainable living principles have you adopted?’. Answers from these participants were analysed using code 25.00 ‘Adoption of sustainable living principles prompted by the EfS website’ of the Codebook. Answers were coded under one level-2 subtheme, i.e. ‘adoption of sustainable living principles’ (*theme code* 25.10), and nine level-3 subthemes. Note that in many cases participants provided more than one example, and in general, answers were brief statements from participants. Table 8.6 presents this data, indicating the number of participants scoring under each subtheme, including attention to follow-up typology groups.

Overall data from Table 8.6 points to adoption of a range of sustainable living principles indicated by 13/18 participants, and prompted by the EfS website. These include a diverse range of principles like recycling (the

most recurrent subtheme), water care, avoid polluting, environmental care of the lake, consume healthy food, enjoying nature, and use of renewable energy, among others (see Table 8.6). This finding implies that the EfS website was able to prompt adoption of sustainable living principles for the majority of participants, based on revisits to the EfS website.

Table 8.6. Participants' reported adoption of sustainable living principles prompted by the EfS website (n = 13; *theme code* 25.00).

Subtheme (Level 2 & 3)	**Group 1** (n = 9)	**Group 2** (n = 1)	**Group 3** (n = 3)	**Totals***	
				L3	**L2**
25.10 Adoption of sustainable living principles	-	-	-	**-**	**13**
Recycling / composting	4	-	1	**5**	
Water care / limiting consumption (e.g. electricity, paper)	3	-	1	**4**	
Education / dissemination of issues	3	1	-	**4**	
Avoid littering / polluting	3	-	-	**3**	
Environmental care of Lanalhue Lake	2	-	-	**2**	
Enjoy nature	1	-	-	**1**	
Adoption at work	-	-	1	**1**	
Renewable energy	-	-	1	**1**	
Healthy food (organic food)	1	-	-	**1**	
Totals (n° coded responses)	**17**	**1**	**4**	**22**	**-**

(*) The left-hand column under 'Totals' indicates the number of participants scoring under each level-3 subtheme; the right-hand column indicates the total participants for each level-2 main subtheme. Note that some participants may have indicated more that one level 3 subtheme.

In regard to typology groups, similar to findings from the last section, data from Table 8.6 does not allow a relevant characterisation of types of

sustainable living principles adopted by participants based on follow-up typology groups. This is because follow-up typology groups are unbalanced in terms of number of participants in each group, making comparison and characterisation between typology groups difficult (e.g. follow-up typology Group 2 only contains one participant, compared to nine from Group 1). Nonetheless, this is an indication that throughout the intervention (from the pre-intervention phase to the follow-up phase) many participants felt they gained a *better understanding* of sustainability issues and of sustainable living. This included six cases of acquisition of *ecological thinking*, represented by the upgrade to typology Group 1 (i.e. Emilio, Julia, Pablo, Mateo, Javiera, Javier, and Marisol). Note that Javier and Marisol originally were categorized under typology Group 3, representing no indication ecological literacy at all, and were finally categorized under typology Group 1, based on their visits to the EfS website.

One recurrent subtheme from Table 8.6 important to highlight is the attention given by 4/13 participants to *educating* and *disseminating* about sustainable living issues to fellow community members. This is in line with similar findings from Section 8.3 (related to motivation to take action; post-intervention phase), where 9/21 participants also reported *education* as an important dimension and a key driver related to taking action towards the sustainability of the socio-ecological system at Lanalhue Lake (this was the second most recurrent subtheme reported by participants in Table 8.3).

For example, Rafael (Group 1) indicated in question Q7c (follow-up survey) that, besides collecting non-biodegradable rubbish from the lake's shore, he also has been talking to his friends about the importance of caring for the native biodiversity present around the lake, and that he has been researching more about local indigenous knowledge. He stated:

> In my visits to the lake I now worry about collecting non-biodegradable rubbish, and to my close friends I have been telling them about the importance of taking care of the native flora that still

> surrounds the lake. As well, I have revalued and researched more about the Mapuche worldview, which is a clear example of how to sustain this area.
>
> (Rafael, follow-up survey, *seq.* 522)

Similarly, Mario (follow-up typology Group 2), simply stated "I try to motivate others to stop the pollution [of the lake]" (Mario, follow-up survey, *seq.* 513). These examples of the *education* and *dissemination* dimension related to sustainable living illustrate a key principle included in and promoted by the EfS website (and already highlighted in Section 8.4.1): the importance of encouraging social interaction and networking among users as a mean to induce social learning (Davis & Sumara, 2005; Guldberg & Mackness, 2009; Krasny & Roth, 2010; Morrison, 2002; Tilbury & Wortman, 2008).

Another subtheme from Table 8.6 important to focus attention on is the one reported by Ana (follow-up typology Group 3), who throughout the intervention demonstrated a great interest towards the EfS website in terms of the benefits that it could bring to her own business (local ecotourism). Ana reported in question Q7c that, besides adopting recycling as a sustainable living principle, she also adopted the use of renewable sources of energy, i.e. solar panels: "Well we recycle our rubbish now, and we are using renewable energy from solar panels" (Ana, follow-up survey, *seq.* 517). This is an important finding for two reasons: firstly, at the time of the intervention solar panels were not common in Chile (in my view, as the researcher, principally due to lack of technology penetration, knowledge and high costs), particularly in the area around Lanalhue Lake characterised by high vulnerability and poverty levels (MIDEPLAN, 2010). This means that the adoption of such technology represented an *innovation* in the area.

And secondly, because Ana throughout the intervention has been categorised as typology Group 3, being a participant with *low* level of understanding of sustainability issues at Lanalhue Lake. So considering

the two last points, the fact that the EfS website prompted such adoption of sustainable living principles in the case of Ana reflects the capacity of the EfS website in doing so, even in participants with a *low* level of understanding. Note that the area where Ana's business was situated had no public electrification at the time of the intervention (due to isolation), meaning local inhabitants were having to rely principally on fossil fuels for power generation.

Regarding question Q7d dealing with the *factor* prompting the adoption of sustainable living principles in participants, answers to question Q7d (n = 12) indicate the following (note that in some cases participants indicated more than one factor):

- 4/12 participants indicated the *EfS website*;
- 4/12 participants indicated *concern over Lanalhue Lake's sustainability*;
- 3/12 participants indicated a *better understanding of issues*;
- 3/12 participants indicated *to achieve sustainable living*;
- And Oscar from Group 3 reported *professional development* as the factor prompting the adoption of sustainable living principles.

The above figures present factors that were key to prompt adoption of sustainable living principles for participants. Note that the *EfS website* is one of the two most indicated factors (along with *concern over Lanalhue Lake's sustainability)* explicitly pointed out by 4/12 participants, despite the fact that answers to question Q7 implicitly put the website as the factor prompting adoption of sustainable living principles, with 14/18 participants reporting so. For example, Manuel (follow-up typology Group 1) answered to question Q7d 'what has prompted you to make those changes?': "To live in a better environment, and thanks to the work realised by the people involved with the website *Lanalhue Sustentable*" (Manuel, follow-up survey, *seq.* 537.02).

In a similar way, Rafael (follow-up typology Group 1), stated "in grand part due to the information provided by the EfS website *Lanalhue Sustentable*,

which apart from describing the current bad situation of the lake, it also presents options to take action that are possible and give hope" (Rafael, follow-up survey, *seq.* 535). This positive message identified by Rafael regarding proposed solutions to address sustainability issues illustrates the inclusion of a key component of the model to develop EfS websites: to embrace positive ways of communicating (Blincoe, 2009).

As well, excepting *professional development* reported by Oscar (follow-up typology Group 3), it can be said that all other factors prompting adoption of sustainable living principles and practices reported by 12/18 participants from the follow-up phase, may have *emerged* from the use of the website by participants. In fact, *better understanding of issues*, *concern over Lanalhue Lake's sustainability*, and *to achieve sustainable living* are all aspects promoted by the EfS website that have been previously reported, either in Chapter 7 or in this chapter. So it can be considered that the website itself may have acted as an *overarching factor* prompting adoption of sustainable living on these participants, but in different forms in different participants. Much can be said based on this finding, both in terms of this being evidence of *expansive activity*, in terms of activity theory, and evidence of *self-nurturing*, in terms of systems thinking, but such discussion will be left for the final chapter where all components of this thesis are brought together.

As a summary of this section assessing the EfS website's capacity to promote adoption of sustainable living principles and practices, findings indicate that participants provided evidence that the website effectively prompted such adoption in the majority of participants. This answers the research question being addressed in this chapter (i.e. the capacity of the website to promote action and *sustainable living* among community members). In particular, the website promoted a diverse range of sustainable living principles and practices in participants, both related to the lake's wellbeing, and related to sustainable living *at home* (and *at work*, in the case of Oscar).

Finally, it appears that the website itself was the main factor prompting such adoption of sustainable living principles and practices. Evidence in this respect signals that the website first created *motivations* to do so, based on participants' first visit to the website (as in Section 8.3.2), and then prompted actual adoption of sustainable living principles *over time*, based on revisits to the website.

8.4.3 Summary

This section assessed if the EfS website was able to promote *action* and *adoption of sustainable living principles* among participants, based on revisits to the website during the follow-up period. As reviewed in Section 8.3, after the first visit to the EfS website, many participants reported *motivations* to take action, and to adopt sustainable living principles. Such motivations were then interpreted as *indicators* of possible actions and adoptions to occur *over time*, after further revisits to the website made by participants during the follow-up period.

Findings from Section 8.4.1 related to participants' reported *actions* carried out during the follow-up period, based on revisits, indicated that the majority of participants carried out a range of different actions. These actions, which in many cases were not targeting root causes of sustainability issues, but were considered a contribution towards the overall socio-ecological sustainability of the area, occurred at three different levels: at the website level, at the lake level, and at the sustainable living level. In every case, the majority of participants reported having carried out actions, with different outcomes envisaged. For example, website-related actions were found to be related to *social networking* instances, which according to literature considered here, would promote *social learning* processes, which in turn contributes towards the overall goals of the website. In terms of lake related actions, many participants reported having visited the lake, which is not a *direct action* as in the Action Competence framework, but rather an outdoor *activity*. Nonetheless, in the view of this study such activity does contribute to the

wellbeing of the system, by playing a part towards the overall socio-ecological sustainability.

On the other hand, ten participants reported having carried out *direct actions* towards the sustainability of the lake. Nonetheless, such actions could not be verified and/or evaluated, in order to confirm them as such, based on the Action Competence framework. Finally, regarding sustainable living-related actions, the majority of participants reported having carried out actions at home, as well as having thought about how to improve their immediate environment.

Concerning findings related to adoption of sustainable living principles, 14/18 participants reported having adopted such principles, and with two other participants reporting not having done so, but at least having considered it. This indicated a good promotion of adoption of sustainable living principles by participants from visiting the EfS website. Note that principles adopted reported by participants were varied, including recurrent things like recycling and water care, to other less recurrent things like adoption of renewable sources of energy or consumption of healthy (organic) food, reported only by one participant in each case. What is more, data also permitted to consider that, in the great majority of cases analysed, the factor prompting the adoption of such sustainable living principles on participants was the EfS website itself. Whether by improving participants' understanding and concerns over sustainability issues, or by motivating achievement of sustainable living on participants, it appears that an *overarching factor* prompting such adoption of sustainable principles was the EfS website, by providing meaningful experiences at different levels for different participants.

The findings presented here directly report to the research question being evaluated in this chapter, i.e. the capacity of the EfS website to promote *action* towards the sustainability of Lanalhue Lake, and to promote the *adoption* of sustainable living principles in participants. Such action and

adoption was here seen to occur *over time*, based on revisits to the website during the follow-up period.

8.5 Summary

As an overview of the capacity of the EfS website to promote action, and adoption of sustainable living principles, some key findings from this chapter emerged. In general terms, the Action Competence framework used in this chapter defined *actions* towards sustainability as being intentional and targeted, and including a sound understanding of the purpose and consequences from learners. In addition, in the context of Lanalhue Lake, actions towards sustainability must contribute, in one way or another, to the overall sustainability of the socio-ecological system. Also, such actions, and the adoption of sustainable living principles, reported in this chapter, were evaluated and interpreted in consideration of the historicity and characteristics of the local socio-cultural context.

Based on the above, findings from Section 8.2 related to participants' pre-intervention actions carried out prior to their first visit to the EfS website indicated that more than half of them reported having carried out actions towards the sustainability of the lake. There was a tendency of this occurring within participants categorised with a *mid to high understanding* of sustainability issues at Lanalhue Lake (i.e. pre-intervention typology Group 1 and Group 2). This lead to the conclusion that the higher the level of ecological literacy of participants, the more tendency they had to carry out actions towards the sustainability of the lake, prior to the intervention. All participants from pre-intervention typology Group 1 reported having carried out actions prior to the intervention, compared to approximately half of participants from Group 3 having reported the same. Regarding the type of pre-intervention actions reported by participants, data provided no antecedents about the nature of such actions, and if they comply with the Action Competence framework presented at the beginning of the chapter.

In regard to findings from Section 8.3 related to participants' motivation to take action and to adopt sustainable living principles after their first visit to

the EfS website, findings indicated overall a high motivation. Participants' reports pointed to motivations to take action at different levels, e.g. lake-related actions or educational related actions, with some tendencies occurring depending on typology groups. In fact, motivations to carry out educational related actions tended to occur within participants categorised as presenting a *mid to high* level of understanding of sustainability issues (post-intervention typology Group 1 and Group 2). In regard to motivations to adopt sustainable living principles, findings indicated that the EfS website also promoted a reflective process around sustainable living in the majority of participants, and including a diverse range of issues. This variety of views regarding sustainable living from participants was interpreted based on participants' unique individual backgrounds and socio-cultural contexts.

Moreover, regarding the *emergence* of motivations to take action and to adopt sustainable living principles, based on participants' first visit to the EfS website, this process was seen to occur as a consequence of the *meaningfulness* of the website to participants. This may have been influenced by theoretical considerations included in the design process of the EfS website. But in particular, due to the consideration of addressing the wide range of characteristics and needs existing in a community, in terms of sophistication and depth of information, and of other ICT affordances. This was illustrated by the finding that the website resulted in a unique and meaningful learning experience for the majority of participants from all three typology groups, prompting *motivations* to take action and to adopt sustainable living principles, based on their first visit to the EfS website.

Finally, findings from the follow-up phase regarding the capacity of the EfS website to promote action and adoption of sustainable living principles *over time*, i.e. based on revisits to the website, also showed a promotion of reported action and adoption of sustainable living in the majority of participants. In this case, three different levels of action were evaluated: website-related actions, lake-related actions, and sustainable living-related

actions. In these three cases, the majority of participants reported having carried out different types of actions, with no real tendency towards a particular typology group. The only tendency found was the one involving direct actions towards the sustainability of the lake, which occurred most exclusively within participants from follow-up typology Group 1. In addition, these reports of direct action were the ones most closely related to a *direct action* as defined by the Action Competence framework, i.e. involving addressing root causes of sustainability issues. However such direct actions could not be verified in those terms due to lack of data detail.

Regarding adoption of sustainable living principles by the majority of the follow-up participants, reports here were diverse, which was interpreted based on individual socio-cultural backgrounds from each participant. Participants also indicated here that the main factor prompting such adoption of sustainable living principles, like for example recycling, composting, water care, or adoption of a healthy diet based on organic food, was the EfS website itself, by offering meaningful affordances and experiences to participants.

Considering that the majority of participants expressed motivations to take action and to adopt sustainable living principles after their first visit to the EfS website, and considering that the majority of participants did report taking action and adopted sustainable living principles, as suggested from findings from the follow-up phase, it can be considered that the EfS website effectively achieved its purpose, in terms of promoting action and adoption of sustainable living principles at the community level. Moreover, this temporal perspective involving first the promotion of motivations, and later the actual promotion of actions and of adoption of sustainable living principles and practices, illustrates characteristics of an expansive activity system, in terms of activity theory: the outcomes after the first visit to the EfS website, i.e. motivations to take action and/or adopt sustainable living principles, later became *precursors* of downstream activities. Note that the above findings from the follow-up phase directly report to the research

question addressed in this chapter, i.e. the capacity of the EfS website to promote action at the community level.

Chapters 6-8 have presented an evaluation of the use of websites for education for sustainability at the community level, with overall findings indicating the potential of EfS websites to achieve socio-ecological sustainability related goals. In particular, the type of use by participants, and the promotion of *understanding* and *action* towards the sustainability of Lanalhue Lake on community members, i.e. participants, was analysed and interpreted under the view of activity theory. The final chapter presents the discussion, conclusions, limitations and recommendations regarding the use of websites for community education in socio-ecological sustainability.

CHAPTER 9 - DISCUSSION, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

9.1 Introduction

Almost four years after the start of this study, both the planet's environmental and socio-ecological sustainability issues, as well as the development of new ICT technologies for linking people through digital communication, are still advancing in an ever-growing and complex way (International Telecommunication Union, 2013; UNEP, 2013). In this context, the expected contribution of this research was to understand how Internet websites could be best used as an educational tool, to assist with the development of ecologically literate communities, and to empower community members to address the issues affecting their local contexts.

This final chapter is a discussion about the use of an Internet website to assist community education for sustainability. This discussion is based on findings from this study in combination with ideas from the literature examined in Chapters 2 and 3. Following the discussion are the conclusions, a set of judgements based on the discussion, in regard to the affordances of the EfS website *Lanalhue Sustentable* to achieve the objectives and goals of education for sustainability, when addressed at the community level in Chile. Finally, the limitations of the present study, implications of findings for the EfS field, and recommendations regarding future research and practice of ICT for community EfS are presented.

9.2 Discussion

Based on literature about Information and Communication Technology (ICT), education for sustainability (EfS), systems thinking, and community education, a theoretical model for the design and development of EfS websites for community education was developed as part of this study. This model was applied in a real socio-ecological context in Chile, addressing the accelerated eutrophication process occurring at Lanalhue Lake, which to date continues to affect the local ecosystem and social wellbeing. Findings from the intervention trial showed evidence that the

model was appropriate in terms of its objectives. The EfS website *Lanalhue Sustentable* developed as part of this study appeared to achieve desired outcomes and goals, namely the promotion of:

- Understanding of local sustainability issues on community members;
- Action towards the socio-ecological sustainability at Lanalhue Lake;
- Adoption of sustainable living principles and practices on community members.

These outcomes are elaborated on and discussed in the following sections, which are structured around each one of the research questions of this thesis.

9.2.1 What ideas could be used to design an EfS website to promote understanding and action for sustainability at the community level?

Many ideas were highlighted in Chapter 2 from Information and Communication Technology (ICT), education for sustainability (EfS), systems thinking, and community education literature said to potentially contribute to the promotion of understanding and action for sustainability at the community level. Key aspects from these different fields, including some theoretical crossovers between these areas of knowledge, were brought together into a theoretical model for the development of EfS websites, presented in Chapter 3. In this section the key ideas and considerations from the theoretical model are discussed in relation to their effectiveness to promote understanding and action for sustainability at the community level.

As indicated throughout this thesis, the principal objectives of EfS websites are the promotion of understanding and action, in relation to socio-ecological sustainability issues affecting communities. As suggested in the literature (CEL, 2009; Davis & Sumara, 2005; Huckle & Sterling, 1996, 1999; Nicolaou et al., 2009; Orr, 2004; Somekh, 2007; Sterling, 2001, 2005; Vrasidas et al., 2007), the effectiveness of such an

educational tool to empower communities in this way could be enhanced by adopting a systems and ecological thinking approach. That is, to look at phenomena holistically, as occurring within a network of interrelated, dynamic, and complex systems; and to focus on the existing relationships between the different components of a system, instead of studying each component individually. In addition, some views from complexity in education literature state that educational systems should act as an enabling and empowering factor, facilitating in a meaningful way the process of education (Morrison, 2002). In the context of the use of EfS websites for community education, this implies that an EfS website can be regarded as an educational facilitator and empowering leader contributing towards the achievement of desired EfS outcomes at the community level.

This systems thinking and complexity theory in education approach is the first aspect addressed in the theoretical model, and the overarching consideration and idea underpinning the design of an EfS website. Such a systems thinking view recognizes that community-based educational settings are unique. Learning processes at the community and non-formal level are characterized by being related to free-choice learning and social construction of knowledge, and by dealing with real-life and locally rooted issues. Table 3.1 in Chapter 3 addressed and summarized these issues and ideas related to adopting a systems thinking approach when designing an EfS website for community-based educational contexts.

Community education literature highlights that communities are constituted by a broad audience (Brookfield, 1990; Menzel & Bögeholz, 2008), and that learning is characterized by being self-directed, voluntary, and based on an individual's motivations and needs (Boyer & Roth, 2005; Falk & Dierking, 2002; Galbraith, 1990). Moreover, education at the community level deals with real life and locally rooted needs, problems and issues, where social interaction is regarded as a key condition for social learning (Nomura, 2004; Thompson, 2002; Tilbury & Wortman, 2008; Webler et al., 1995). Within such a context-dependent setting involving a broad diversity of learners with individual's backgrounds, motivations and needs, systems

thinking literature provides some guidelines and approaches to address such an educational context.

The principal systems thinking idea to address community-based educational settings is to regard the EfS website as a learning facilitator that enables the learning process and empowers learners (Morrison, 2002). Moreover, an EfS website not only has to facilitate learning, but also the educational system based on the EfS website needs to constantly be nurturing itself as a way to facilitate the learning process. Four key conditions for the creation and nurturing of educational systems were reviewed in Section 2.3.2. These include the promotion of interactivity, diversity, means for learners to affect each other, and a decentralized control structure (Davis & Sumara, 2005). In addition, for the EfS website to nurture itself as an educational facilitator over time, the design team and website administrator(s) require to constantly update the information on the website based on socio-cultural, ecological, technological and educational factors.

So, in order to address a broad audience involving a range of types of learners with different backgrounds and needs, where relevant issues are locally-rooted, and where social interaction is a key for social learning, an EfS website requires to facilitate learning in a meaningful way to, ideally, every individual learner. In turn, to design and develop a meaningful educational system based on a website, systems thinking considerations and ideas were included during the design of the EfS website *Lanalhue Sustentable*. For example, in relation to the four key conditions presented above from Davis and Sumara (2005), the interactivity of the EfS website was enhanced by providing and maximizing its set of ICT affordances (e.g. multimedia features) that were aimed at making the website accessible and attractive to learners, in order to promote the interactivity between learners and the website. In addition, other ideas from ICT and community education were also included here to promote the interactivity of the website. These are mostly related to addressing the socio-cultural context of the target community. More on this aspect follows.

Regarding diversity within the EfS website *Lanalhue Sustentable*, this was enhanced by including a wide range of types and sources of information addressing a broad variety of topics of interest to local members (identified during the pre-design research phase). Diversity was also addressed and enhanced by involving end-users during the design phase to include locally-based views during the design of the website, and by inviting a range of collaborators that provided their own perspectives on the website in the form of short articles addressing issues of common interest. Regarding means for learners to affect each other, indicated by Davis and Sumara (2005) as a key condition to create and nurture educational systems, such promotion of interaction between learners was addressed through the inclusion of Web 2.0 features.

However, the evaluation of the impact of Web 2.0 and social media features in relation to the achievement of understanding and/or action was outside the scope of this study and was not considered as an evaluative aspect during the research design.

Concerning the fourth condition to nurture educational systems, related to having a decentralized control structure, such a type of control was aimed to be achieved through the invitation to collaborators to submit their own work, which was not controlled by the design team but only directed through guidelines aimed at achieving a particular EfS learning approach and/or objective. In essence, many collaborators and local organizations were invited to have their own 'space' within the EfS website, and were prompted to submit whatever they considered relevant, in consultation with the design team, but without restrictions in term of content. Examples of these can be found throughout the EfS website *Lanalhue Sustentable* (e.g. Red Contulmo within the Experiences and Examples section of the website).

Having included such ideas from systems thinking for the creation and nurturing of educational systems during the design and development process of the EfS website, the other key idea from systems thinking was

to approach the website as a learning facilitator that can provide meaningful experiences to learners. This meant that the website had to adapt to local conditions. This was in part sought through evaluating, understanding and addressing the local socio-cultural and technological characteristics and needs of the target audience during the design and development of the website, for which a pre-design research phase was carried out (for methodological aspects of the pre-design research phase see Sections 4.5; for practical and data collection related aspects see Section 5.3).

A key premise from literature related to socio-cultural considerations of ICT use, is that the use of ICT may enhance learning in educational contexts, but it does not cause it to happen (Aivazidis et al., 2006; Nomura, 2004; Somekh, 2007). Rather, it is the learner, as well as the learner's socio-cultural context, that ultimately determines if an ICT tool is culturally meaningful (Kling, 2000; Knight et al., 2009; Selinger, 2004; Woo, 2009). This same socio-cultural aspect of ICT use is highlighted within systems thinking under the notion of the importance of the learning environment for the promotion of meaningful experiences for learners (Murray, 1994; Sterling, 2005; Sumara & Davis, 1997). Therefore, to facilitate learning in a meaningful way, the design process of the EfS website needed to understand and address local characteristics and needs, which were evaluated during the pre-design research phase of this study.

Moreover, Dunn and Marinetti (2008) further pointed out that ICT services, such as educational websites, are also shaped by the culture in which, and for which, they are designed. Thus stressing the importance of not only considering the learners' socio-cultural contexts and needs, but also the designers' socio-cultural background, which influences and determines the type of affordances finally offered by an educational website such as an EfS website. In terms of the theoretical model, this suggests that ideally the design team of any EfS website should come from the target audience, or at least be familiar with it, as this could maximize the affordances

offered by an EfS website. The last was the case for the development of the EfS website Lanalhue Sustentable. As no satisfactory website designer was found in the target community, the web design team finally came from outside the target community. In order to familiarize the design team with the local issue, they were invited to stay a week at the Lanalhue Lake, where they had first hand experience with different aspects related to the local sustainability issue, achieving a familiarization with the targeted socio-ecological sustainability issue.

Coming back to the pre-design research phase, the literature emphasizes that to achieve socio-cultural meaningfulness through ICT tools it is critical to clearly understand and address the characteristics and needs of the target community (Chu & Martinson, 2003; Dunn & Marinetti, 2008; Knight et al., 2009; Murray, 1994; Nomura, 2004; Tilbury & Wortman, 2008; Sterling, 2005; Thompson, 2002). This involved, for example, an understanding of the existing conceptions, including alternative conceptions, held by local community members of the target audience regarding local sustainability issues, in order to directly address them through the affordances offered by the EfS website (Aronson, 2007; Ballantyne & Packer, 2005; Menzel & Bögeholz, 2008; Selwyn, 2006; Webb, 2005). Outcomes from the pre-design research phase, discussed in Section 5.3.2, allowed the design team to target specific aspects of the local context, such as common alternative conceptions held by local community members, or website feature preferences among participants of the pre-design research phase.

Besides the ideas and considerations related to the characteristics of community-based education, local socio-cultural characteristics and needs of the target community, and systems thinking approaches to address such a type of educational settings, other key ideas from the theoretical model were to adopt EfS-related learning approaches and strategies, and to include ICT-related features and considerations.

Key EfS related learning approaches and ideas came from all four areas of knowledge reviewed in this study, and had in common the promotion of community EfS outcomes. These sets of ideas are summarized in Table 3.2 of the theoretical model presented in Chapter 3. For example, the promotion of ecological literacy, a key EfS learning approach, was also highlighted in literature from systems thinking and ICT; or the promotion of critical thinking, another key concept within EfS, was also indicated as crucial in literature from systems thinking and ICT. Other key ideas from Table 3.2 included the promotion of long-term thinking, political literacy, ethical values around socio-ecological sustainability issues, and transformative learning. This last relates to the idea of changing and/or transforming mainstream paradigms of thinking that have led to current sustainability issues, to new ways of thinking that promote ecological sustainability (Lovelock, 2006; Orr, 2004; Räthzel & Uzzell, 2009).

Regarding ICT-related features and considerations, from ICT literature a series of design considerations and ideas were found useful to be included as part of the theoretical model. These ideas were summarized in Table 3.5 under four categories: multimedia features; Web 2.0 features; general website features and affordances (e.g. enhance accessibility); and the concept of affordance maximization, related to the notion of maximizing the affordances and possibilities offered by the EfS website in order to provide a meaningful experience to users. The selection, design, shaping and development of such types of ICT features and affordances within the EfS website *Lanalhue Sustentable* was carried out based on findings from the pre-design research phase, and implemented during the design phase of the website (see Section 5.4).

In summary, a range of ideas were found in the literature that could potentially contribute to promote understanding and action for sustainability at the community level through the use of an Internet website. These were organized in Chapter 3, implemented as in Section 5.4, and evaluated in Chapters 6, 7 and 8. It is the combination of all key ideas identified from the literature that assisted in the promotion of

understanding and action for sustainability in the context of Lanalhue Lake. Overall, the combination of ideas from the theoretical model was found to be effective in the promotion of understanding and action among participants from the target community.

These theoretical ideas were adapted to the socio-cultural, technological and ecological context found at Lanalhue Lake, through the development of an EfS website based on local characteristics and needs identified during the pre-design research phase. In that sense, it may be suggested that a key idea to develop an EfS website to promote understanding and action for sustainability at the community level is to achieve an understanding of the target community. This is in order to make the website as meaningful and relevant as possible for learners, which is the first step to promote EfS outcomes through the use of Internet websites.

The next section discusses issues related to the type and purpose of use of the EfS website *Lanalhue Sustentable* by local community members.

9.2.2 How do community members use an EfS website and what for?

This two-part research question points to the types of use, individual contexts of use, and purposes of use of the website by participants of the target community. Findings indicate that participants' experiences using the website were based on their individual backgrounds, needs, and context of use. From an activity theory perspective, this indicates that the use of the EfS website as an educational tool was determined by socio-cultural conditions of use, the structure of the local community, the individual motivations and needs of participants, and the affordances provided by this educational tool to participants. These ideas are discussed below.

After a pre-design research phase, and an EfS website design phase that altogether lasted 10 months (during 2010), the EfS website *Lanalhue Sustentable* (http://lanalhuesustentable.cl) was ready for use as the

research instrument. Twenty-four local community members accepted the invitation to participate in this study. They were presented with the EfS website once at the start of the intervention, and then were invited to revisit it as many times as they wanted to during the follow-up phase (18/24 participants took part in this phase). To assess if the EfS website Lanalhue Sustentable was capable of promoting understanding and action around sustainability issues at Lanalhue Lake, it was first necessary to understand how these community members used the website, and what they used it for. Quantitative data from Google Analytics, as well as qualitative data from the surveys (i.e. pre-intervention questionnaire, post-intervention interviews, and follow-up online survey) were used to answer this two-part research question.

Data from Google Analytics, which due to data resolution issues only provided input at the cohort level, indicated the following. For the first visit, participants as a cohort had a tendency to visit sections of the EfS website related to local issues. In particular, visits were focused towards sections addressing the main issue of the EfS website: the accelerated eutrophication process of the Lanalhue Lake. Different aspects and considerations of the theoretical model can be linked to this tendency. For example, during the pre-design research phase the eutrophication of the lake as a topic was found to be highly relevant to local community members and local authorities (see Section 5.3.2). This motivated the design team to address this sustainability issue on the website as its principal scope. This means that many learning approaches and strategies were principally focused on promoting understanding and action regarding the eutrophication process of the Lanalhue Lake.

Similarly, the ICT-related features such as videos and photos, as well as the presentation and layout of the Home page of the website, were also targeted to highlight the eutrophication process as the main aspect of the website. Participants visiting the Home page of the EfS website for the first time were prompted and directed to review sections related to the eutrophication process in the first instance, as many elements of the

Home page pointed towards that particular issue. Thus, the understanding of what constituted relevant sustainability issues to participants, and the implementation of such issues during the design and development of the EfS website, contributed to the finding obtained through Google Analytics: participants as a cohort preferred to visit sections related to the eutrophication of the lake during their first visit. Such a claim may be an illustration of the effective implementation of findings from the pre-design research phase during the design phase of the EfS website.

Concerning participants' reported revisits during the follow-up phase, the tendency of sections visited was also related to local sustainability issues, however without the same clear tendency as for visits from the intervention phase (i.e. participants' first visit to the EfS website). Despite the fact that these sets of data were different in nature (i.e. quantitative vs. qualitative data), they highlight an important point for this discussion. It can be suggested that participants' first visit and revisits from the follow-up phase occurred in different contexts. For the first visit, participants were immersed within a research context. They had an introductory briefing, followed by a questionnaire survey, and then visited the EfS website for the first time, with most participants doing so from the researcher's laptop computer. This first interaction with the EfS website may have represented a new experience to some participants. The consideration that they were the first individuals apart from the design team to visit an EfS website dedicated to the socio-ecological sustainability of Lanalhue Lake illustrates the last claim.

But revisits to the EfS website during the follow-up period were carried out in a different context. They occurred up to five months after the first visit, and most probably at a place where participants normally accessed the Internet. Participants might have revisited the EfS website at their ease and with availability of time, and already knowing what to expect from it. They might have explored sections that they did not visit during the first visit. And in many cases they revisited the website more than once, with the extreme case of Rafael reporting more than fifteen revisits.

Based on the above, there is an indication that the same EfS website user may visit the website with different expectations and needs depending on the context of each visit. In each case, the type of use of the website may be driven by the particularities of the context, whether internal or external to the user. In addition, the different types of affordances provided by the website, which in turn are finally shaped and determined by the background of each individual user, also determine how users interact with the EfS website over time. As discussed in the previous section, education at the community and non-formal level involves dealing with a broad range of types of adult learners, each one presenting a particular background, as well as learning motivations and needs (Brookfield, 1990; Chu & Martinson, 2003; Menzel & Bogeholz, 2008). Therefore, and bringing in an activity theory perspective, the outcomes of every single EfS website-based activity system (as in Figure 5.4) are determined by individual singularities of learners, and by the socio-cultural background and structure of the local community. This claim addresses the first part of the research question discussed here, related to the type of use of the website by community members.

In regard to the second part of the research question being discussed in this section, i.e. what participants used the website for, or the purpose of revisits, qualitative data from the follow-up survey identified three general purposes: (1) to access information, whether new information or deeper review of existing information; (2) to apply the information contained on the website, which in Chapter 6 was interpreted as evidence of an expansive activity system (Engeström, 2001) (see Section 6.4.1.2); and (3) to achieve social networking with other users and related organizations through the website (only reported by two participants).

These findings provided evidence of the capacity of the EfS website *Lanalhue Sustentable* to adopt characteristics of an educational facilitator, by enabling participants to address the needs underpinning their revisits, and providing means for interaction between learners. When given the opportunity to highlight a last comment in Q9 of the follow-up survey, the

most recurrent subtheme was the opinion that the EfS website was 'good for information access'. The interpretation of such a finding is that the EfS website seemed to be perceived as a learning point by these participants. According to complexity theory in education, being an enabling and empowering factor, as well as to provide the means for the components of an educational system (learning actors) to interact between them (the third general purpose of revisits reported above), are characteristics of an educational facilitator (Davis & Sumara, 2005; Morrison, 2002).

In a broader view, the findings also point to the meaningfulness achieved by the majority of participants through the EfS website (as reported in Chapter 6). As an educational facilitator, the EfS website was able to provide a range of affordances capable of fulfilling different motivations, expectations and needs existing in the cohort. For example, and as indicated above, the second main purpose to re-visit the website was, for some participants, to apply its information in planned activities and actions. One participant who scored under this subtheme was Mateo, a primary school teacher from Contulmo, who stated when asked about the purpose of his revisits: "[I re-visited the website] to retrieve information that I can use and complement with the bioethics unit of my Philosophy class" (Mateo, follow-up survey, *seq.* 438).

Similarly, but looking towards satisfying other type of needs were the cases of Javier and Rafael. Javier reported being interested in learning more about the Mapuche culture, this topic being his sole interest of revisits, according to data from Table 6.13, and Rafael, the participant that most re-visited the website, reported interest in further reviewing the website overall, simply because he found it of good quality. From an activity theory perspective, the above and other cases indicated expansive transformation of the activity system based on the EfS website as a mediating tool. This may be because participants were seeking specific outcomes by revisiting the website, to fulfil later motivations and/or activity systems.

This brings the discussion to a more overarching point highlighted in the literature, and discussed in the previous section. That is, communities represent and include a wide range of members, involving a variety of backgrounds, perspectives, characteristics and needs (Brookfield, 1986, 1990; Galbraith, 1990; Menzel & Bögeholz, 2008; Thompson, 2002). In relation to the research question addressed in this section, activity theory indicates that all members of a community are in turn determined by their socio-cultural historicity and context; by the particular structure of the community (i.e. the rules); and by the individual role each community member plays (i.e. the division of labour) (Cole & Engeström, 2001; Leadbetter, 2005; Yamagata-Lynch, 2007). Therefore, in order to understand how community members used the EfS website, and what for, it was necessary to understand who these community members were (i.e. the participants), in relation to the particular socio-ecological context of the target community and individual backgrounds. In the end, how the website was used, and what for, directly depends on who is using it.

Evidence supporting this is that, for example, the participants who were teachers, reported using the EfS website associated with teaching activities. So, how these community members used the EfS website and what for appeared to depend to some extent on their particular and individual socio-cultural backgrounds and contexts.

This illustrates a theoretical consideration from community education literature related to the importance of addressing the broad audience of the target community (Brookfield, 1990; Galbraith, 1990). During the design phase it was impossible to foresee the characteristics and backgrounds of the community members that would participate in this study. Instead, to satisfy any possible individual background existing within the target community, it was necessary to include a wide and varied range of depth and sophistication of information, ICT affordances (e.g. multimedia affordances), and EfS affordances (e.g. actively addressing alternative conceptions found on the community), all these based on the pre-design research phase. This seems to indicate one of the crucial

aspects of the use of EfS websites at the community level: they can potentially reach a large number of users within a community if considerations and ideas related to provide a wide range of variety, intensity, and sophistication of educational affordance are followed.

Other theoretical considerations that directly enhanced this aspect of the website include addressing locally rooted relevant issues, understanding and addressing the local characteristics and needs, and providing a positive way of communicating sustainability issues and challenges.

Based on the discussions about theoretical ideas to inform the development of EfS websites (in Section 9.2.1), and the type and purpose of use of the EfS website *Lanalhue Sustentable* by participants discussed in this section, the two following sections set the discussion around the effectiveness of the EfS website to promote understanding and action for socio-ecological sustainability in the context of Lanalhue Lake in Chile.

9.2.3 Does the use of an EfS website improve understanding of sustainability issues among community members?

One of the key objectives of the EfS website *Lanalhue Sustentable* was to promote ecological understanding of sustainability issues present at Lanalhue Lake in Chile. Findings indicated that the EfS website not only promoted different types of understanding, such as deeper understanding or transformative understanding, but also increased participants' motivations and interests over the issues affecting the local ecosystem. In addition, these types of change in understanding occurred across all three typology groups defined in chapter 7. Overall, it can be said that the EfS website *Lanalhue Sustentable* was able to promote understanding of sustainability issues within the majority of participants, including transformative types of change in understanding, which are key to EfS. These findings illustrate the effectiveness of the EfS website to facilitate the learning process for many of the participants from the local community. These findings are further discussed below.

As reviewed in Chapter 2, despite the high levels of awareness achieved since the early environmental education from the 1970s, scholars have recognized that, in general, there is still an important lack of knowledge and understanding about sustainability issues at the societal level (Bolstad, 2003a; Orr, 2004; Oulton & Scott, 2000; Sterling, 2001). In the case of the Lanalhue Lake, data from the pre-design research phase (i.e. data collected through interviews with local experts, and through the questionnaire survey 2b; see Section 5.3 for details) indicated a similar tendency within the local community.

People from the community at Lanalhue Lake were aware that the wellbeing of the lake was at risk. They knew that the accelerated eutrophication of the lake was affecting the local biodiversity, and was also affecting them, in particular in terms of the recreational enjoyment of the lake by locals and visitors. But the understanding of sustainability issues affecting the lake was found to be low (see Section 5.2.1.1). This view is supported by findings from Section 6.2.1.2, where Q11 of the pre-intervention questionnaire asked participants about their knowledge regarding sustainability issues at Lanalhue Lake, with 2/3 of participants self-reporting a poor knowledge, and only Romina indicating a 'very good' knowledge.

The change in understanding of issues related to the sustainability of the Lanalhue Lake based on the use of the EfS website was assessed by evaluating participants' levels of understanding at three different stages (this was based on the *ecological literacy framework* presented in Section 7.2). In a first instance, answers provided by participants during the pre-intervention questionnaire permitted to establish three pre-intervention typology groups: Group 1 with 7/24 participants, characterized by a high level of understanding and of ecological literacy; Group 2 with 8/24 participants presenting a medium level of understanding and some degree of ecological literacy; and Group 3 with 9/24 participants with a low level of understanding and no indication of ecological literacy (see Table 7.4 in Section 7.2.3 for details).

The change in understanding after participants' first visit to the EfS website was assessed based on answers provided by them during the post-intervention interview (see Section 4.5.2 for details on this data collection phase). In particular, questions Q4 and Q4a explored changes in understanding in participants based on their experience visiting the website for the first time, by asking if they felt their understanding changed after visiting the website. Four recurrent level-2 subthemes were identified from participants answers, detailed in Table 7.5. Some of the recurrent subthemes identified from participants' answers seemed to reflect some apparent types of change in understanding, such as improved understanding, deeper understanding, and transformative understanding. In particular, level-2 subtheme 'thinking shift' (*theme code* 16.10) included three level-3 subthemes: 'new perspectives towards issues'; 'transformative understanding'; and 'acquired ecological perspective'. These three subthemes were taken into consideration to establish the post-intervention typology groups, following guidelines from the ecological literacy framework, which defined typology groups based on evidence of presence of some degree of either systems thinking and/or ecological literacy in participants' answers.

Participants reporting 'new perspectives towards issues' were characterized by providing evidence of a change in understanding based on new or different perspectives towards different aspects of the sustainability of Lanalhue Lake. However, the other two types of thinking shift were considered more important in terms of the desired EfS outcomes of the website. 'Transformative understanding' and 'acquired ecological perspective' implied that participants were able to provide evidence of ecological literacy perspectives, based on the ecological literacy framework used to defined typology groups. This means that such participants were able to understand and recognize the connections between how the human component was related to the eutrophication of the lake, and how this in turn affected the local community and associated natural ecosystems. Emilio and Julia, both from pre-intervention typology

Group 2 (and from Cañete), were upgraded to post-intervention typology Group 1, after indication of 'acquisition of ecological perspective'.

Regarding evidence of transformative understanding, it appeared that this was more likely to happen within participants from pre-intervention typology Group 3 as they were characterized by no evidence of prior ecological literacy levels, meaning that a transformative understanding type of thinking shift, in terms of the ecological literacy framework, would make them acquire some degree of ecological literacy. This was the case with Soledad and Marisol, both from pre-intervention typology Group 3, and the only participants scoring under subtheme 'transformative understanding' (*theme code* 16.105). These two participants were upgraded to post-intervention typology Group 2, based on evidence of the presence of ecological literacy perspectives in their answers to Q4 and/or Q4a, regarding the sustainability issues at Lanalhue Lake.

Overall, after the first visit to the EfS website the cohort of participants had five participants moving from a lower typology to a higher typology. However, data from Table 7.5 provides further insights on the overall understanding change of the cohort, as all twenty-four participants of the post-intervention interview reported at least an 'improved understanding' after visiting the website, with ten cases of thinking shift. In addition, Table 7.5 also indicates that six participants reported a new motivation towards the sustainability of the lake, or to sustainable living in general, which in some cases were explicitly reported as stimulated by the EfS website (see Section 7.3 for details).

Similar findings were obtained after analyzing answers from the follow-up survey related to a change in understanding over time based on revisits to the EfS website. Tables 7.8 and 7.9 from Section 7.4 provides insights regarding types of change in understanding related to the luchecillo in particular, and to the Lanalhue Lake in general, respectively. During the follow-up period, 5/18 participants reported a 'transformative understanding', with the difference, compared to cases based on the first

visit only, that these five participants indicating a transformative understanding were all from post-intervention typology Group 1. This means that after many visits to the website during the follow-up period, participants already presenting a degree of ecological literacy, and a high level of understanding of sustainability issues at the lake, were able to experience a transformative type of change in understanding, where new information and knowledge were accommodated in participants' conceptual structures (see Section 2.5.1 for details on such constructivist views of learning).

Similarly, another 6/18 participants suggested an acquisition of ecological perspectives, but in this case such participants were coming both from post-intervention typology groups G2 and G1. Note that none of the participants from post-intervention typology Group 3 presented indications of such types of change in understanding, which perhaps suggests a 'literacy divide' in terms of these participants with initial low ecological literacy being unable to achieve acquisition of ecological literacy perspectives based on the EfS website. To support such a claim more data would be needed, related to whether these participants would have needed more revisits to achieve such a change in understanding, or if simply the theoretical model failed to promote transformative types of understanding on this type of participant. But, as indicated in Tables 7.8 and 7.9, participants from post-intervention typology Group 3 did provide indications of change in understanding, but related to achieving a better understanding about the luchecillo and the lake's sustainability, instead of a thinking shift over those issues. Whether these participants from post-intervention typology Group 3 that experienced a better understanding would have acquired ecological perspectives over time based on further revisits or not is unknown.

In addition, as indicated from literature on community education (Section 2.5), and as highlighted in the theoretical model (Section 3.2), other non-EfS website related factors may contribute to the learning process for community members, such as social interaction at the community level not

mediated by the EfS website. Hence, in order to achieve a transformative type of change in understanding, participants from post-intervention typology Group 3 may have benefited from such a type of social interaction related learning process to achieve a thinking shift, for example, by discussing with fellow community members issues related to the lake, and learn from there.

Overall, changes in understanding based on revisits were more frequent than changes in understanding based on the first visit. This was interpreted under the assumption that the follow-up period provided better opportunities for participants to process change in understanding. As well, during the follow-up period participants would have had more chances to cover what potentially could change understanding on them. Based on the above discussion illustrating the development of an improved understanding on the majority of participants, including cases of transformative understanding and other types of understanding related to a thinking shift, it can be concluded that the EfS website was able to increase the overall ecological literacy and level of understanding of this cohort of participants.

In terms of the factors, or theoretical ideas from the model, that promoted such transformation of understanding among participants of this study, as discussed in the previous two sections the view here is that no direct relationship can be found between one or more theoretical consideration(s) and a particular outcome of the use of the EfS website by participants. This is because, as viewed from a systems thinking perspective, it is the combination of all the theoretical components underpinning the EfS website that produces the emergence of a particular outcome. Moreover, as the final desired outcomes of the EfS website were to promote understanding and action for sustainability in the context of the Lanalhue Lake, the theoretical ideas and considerations from the literature informing the model for developing EfS websites were all targeted at achieving such outcomes. In addition, from activity theory, every individual learner brings to the educational system determined by the EfS website as

a mediating tool their own particular background, motivations and needs, making every outcome of this EfS website-mediated activity system unique at the individual level.

Nonetheless, some participants did provide evidence that could highlight a particular consideration over others as factors facilitating the learning process and associated change in understanding. For example, as highlighted in the literature, providing types of ICT-based educational affordances, such as the use of multimedia, could enhance the learning process for some participants (Becta, 2008; Caladine, 2008; Mayer, 2002; Somekh, 2007; Woo, 2009). As discussed in Section 9.2.1, evidence suggested that multimedia affordances included on the EfS website, such as photos and videos, assisted the learning process around sustainability issues for Mario and Ramiro. As reported by these participants, the photos and videos on the website allowed them to visually 'see' aspects of the degradation of the lake that would be difficult to transmit through, for example, simple text.

Taking this to an EfS perspective, the use of these types of multimedia assisted these participants to develop vicarious experiences linked to affective and emotional domains based on visual evidence from the photos and videos. In addition, photos and videos not only provided evidence of the degradation of the lake, but also provided the effects related to the eutrophication process of the lake. Within the context of the 'evidence, effects and efforts' learning strategy suggested by Ballantyne, Fien and Packer (2001), such vicarious experience providing evidence and effects of the eutrophication process at the lake, if complemented with guidelines indicating the necessary efforts to overcome sustainability issues, may have assisted these and other participants to challenge their existing conceptions and adopt new information assisting the development of a new understanding. This process could also be complemented with other theoretical considerations, such as providing positive ways of communicating sustainability issues, or promoting knowledge integration and inquiry by showing participants the big picture of the sustainability of

the lake, which as discussed in Section 2.4.3, may assist the development of critical thinking and systems thinking, both being key EfS-related learning approaches, and approaches recommended in the literature for the development of an ecological literacy (Capra, 2005b; Orr, 2004).

Other multimedia affordances initially considered in the theoretical model that may also have promoted a learning process as in the case of photos and videos could not be assessed due to limitations of the study. In particular, the use of animations representing the associated ecological processes of the eutrophication of the lake would have been interesting to evaluate. But development of animations were expensive and out of reach. Similarly, the use of Web 2.0 and social networking features were also an integrative part of the ICT theoretical considerations for the development of EfS websites, said to assist the learning process at the community level based on social interaction, as discussed earlier in this section. Although such features were included in the EfS website Lanalhue Sustentable, their impact on the community members was not evaluated. A different research design, addressing different research questions, would have been needed to do so.

Another ICT-related theoretical consideration that may have contributed to the overall change in understanding reported above was the idea of maximizing the general affordances of the website. In particular, the issue of maximizing the accessibility of the website to participants could have contributed to making the EfS website more relevant and meaningful based on the affordances provided by the website to participants. Some evidence from Section 6.3.2 is the answers to Q1 of the post-intervention interview provided by some participants. As discussed in Section 6.3.2, many participants commented on the clear messages of the website, making it easy to understand (n = 10/21). As discussed in Section 2.4 and in Chapter 3, the maximization of the affordances offered by the EfS website can provide a more meaningful experience to learners, which in turn can contribute to the learning process.

The discussion in this section illustrates the capacity of the EfS website *Lanalhue Sustentable* to act as an educational facilitator and leader. It enabled access to existing information by the general community in a meaningful way, and through an educational process directed towards EfS goals. It made knowledge available to the local members of the Lanalhue Lake community, for example, by means of multimedia features, with indication of improvement of the levels of understanding and of ecological literacy of the cohort of participants.

One aspect of such learning facilitation and leadership is that it is based on ICT technology. Using websites for community EfS can boost the reach of EfS programs if ICT access is readily available. This not only gives the potential to EfS educators to reach a larger number of learners without the need to physically interact with them, but can also enhance the access to information in a meaningful and relevant way. Having said that, the evidence presented and discussed in this section suggests that the EfS website *Lanalhue Sustentable*, including all its repertoire of affordances, was able to promote understanding of socio-ecological sustainability issues amongst local community members, in the context of the Lanalhue Lake in Chile. The following section discusses the ability of the EfS website to promote action for sustainability at the community level.

9.2.4 Does the use of an EfS website promote action, and adoption of sustainable living principles among community members?

The action component is considered a key aspect in EfS and within the present study, and is what can bring about real change towards sustainability (Daudi, 2008; Jensen & Schnack, 1997; Orr, 2004). Taking action implies influencing one's environment to achieve a new desirable state, in this case the socio-ecological sustainability of the Lanalhue Lake in Chile. In the view of activity theory (AT), actions, or 'activities' in AT terms, are underpinned by motivations, and influenced by the socio-cultural context, background, and structure of the local community (Cole & Engeström, 2001; Leadbetter, 2005; Yamagata-Lynch, 2007). In this study, the starting premise was that actions may be promoted through the

use of an EfS website. Findings indicated that, for the majority of participants, the EfS website *Lanalhue Sustentable* appeared to promote both action towards the local socio-ecological sustainability, and adoption of sustainable living principles. In discussing the answer to this research question, this section reviews findings related to the promotion of action, and of adoption of sustainable living principles, prompted by the EfS website, and relates these to considerations from the theoretical model.

Findings from Q13 of the pre-intervention questionnaire, dealing with participants' prior actions towards the sustainability of Lanalhue Lake, indicated that some participants were already carrying out actions contributing to the socio-ecological sustainability of the lake (n = 15/24; see Section 8.2.1.), regardless of their typology groups. Five recurrent level-2 subthemes were identified from answers provided by these participants, which indicated actions related to (in order of recurrence): environmental care; education; communication and discussion; work-based actions; and sustainable living related actions, with Emilio (who lives by the lake on the Cañete side) being the sole participant scoring under this last category. He reported organic recycling and composting as actions related to sustainable living. Nonetheless, because such actions were carried out outside the control and scope of this study, they could not be verified in terms of meeting the criteria from the Action Competence framework, presented in Section 8.1, which essentially categorized actions based on the conscious targeting of them to an issue, on whether they addressed roots causes of the issue, and if they included a sound understanding of the motives and reasons to carry out the actions.

After the pre-intervention questionnaire, participants were presented the EfS website for the first time. Following their first visit to the website, a set of three questions from the post-intervention interview (Q7, Q7b and Q8; see Appendix F for details) evaluated their motivations to take action towards the sustainability of the lake, or towards adopting sustainable living principles and practices. Findings discussed in Section 8.3.1 indicated that 21/24 participants reported motivations to take action based

on the first visit to the EfS website. The most recurrent type of motivated action identified was ‘motivation to take action / get involved’ (*theme code* 17.075), this being a general type of action indicated by 14/21 participants across all typology groups.

Another more specific type of action was education-related actions, reported by 9/21 participants, mostly from pre-intervention typology groups G1 and G2, who appeared to consider education as a key driver for achieving sustainability at the local level. For example, Romina (a teacher from Cañete) was motivated to teach children about sustainability issues occurring at Lanalhue Lake, with the hope that such children would later teach their parents at home. Or Rafael, who lives by the lake in Contulmo, reported motivation to communicate and explain the issues present at the lake to friends and relatives.

In summary, the overall finding from Section 8.3.1 is that the EfS website stimulated motivations to take action towards the sustainability of the lake in the majority of participants, across typology groups, and at different levels (e.g. education level, business level, and lake level; see Table 8.3 for details). Based on the activity theory view that motivations are components of activity systems, these motivations reported by participants were interpreted to be indicators of possible actions that the majority of participants were stimulated to carry out, prompted by the EfS website. In addition, and as expected from activity theory, it appeared that motivated actions were directly related to participants’ particular socio-cultural context and individual backgrounds, making motivated actions relevant and meaningful within their own milieu.

Regarding motivations to adopt sustainable living principles and practices prompted by the first visit to the EfS website, 18/24 participants reported that the EfS website prompted a reflective process in them in relation to considering living sustainably. As discussed in Section 8.3.2, and similar to findings discussed above in relation to motivations to take action, different participants experienced this reflective process from their

particular point of view, and referring to their individual real-life contexts. From an activity theory perspective, each participant brought into this reflective process, prompted by the EfS website, their own characteristics and needs, which in turn are linked to their individual historical and socio-cultural realities (Kaptelinin, 1995; Leadbetter, 2005).

Findings from Sections 8.3.1 and 8.3.2, dealing with motivations to take action and to adopt sustainable living principles, based on participants' first visit to the EfS website, suggest that the website was able to promote, within the majority of participants, both motivations to take action towards the sustainability of Lanalhue Lake, and motivations to adopt sustainable living principles. In addition, findings also showed that each participant developed an individual experience from the use of the website, based on their backgrounds and socio-cultural contexts. It appeared that such outcomes based on the first visit to the website were based on the meaningfulness and relevance achieved through the website. The indication that participants were motivated by the website underpins such a claim, as from an activity theory perspective, motivated actions are meaningful to learners within their particular and individual socio-cultural contexts and reality (Krasny & Roth, 2010; Yamagata-Lynch, 2007). In turn, according to community education literature, meaningfulness for learners depends on addressing relevant local characteristics and needs and learners' individual backgrounds (Brookfield, 1983; Menzel & Bögeholz, 2008; Thompson, 2002), these being key ideas and considerations from the theoretical model.

In regard to participants' actions and adoption of sustainable living principles based on revisits to the website during the follow-up period, findings from Q6 discussed in Section 8.4.1 indicated that the EfS website prompted a series of actions, whether website-, lake-, and/or sustainable living related actions. In terms of the Action Competence framework (AC framework), some actions were more related to targeting root causes of sustainability issues, for example, 'taken any other direct action to help improve the lake's environment', when compared to 'visited the lake',

which in terms of the AC framework would be more related to an activity rather than an action for sustainability (details on the AC framework can be seen in Section 8.1).

However, as noted in Section 8.4.1, the design of the follow-up survey limited the assessment of actions in terms of the AC framework, and in terms of exploring the details regarding reported actions. This was principally because the follow-up survey was intended to be short and brief (having to cover other aspects too), as it was carried out through an email invitation and needed to be appealing to respond to. Nevertheless, in consideration of reported motivations from Section 8.3, actions indicated in Section 8.4.1 were still representing participants' self-reported actions that they carried out, and that based on the AC framework, were considered to contribute in one way or another to the overall sustainability at Lanalhue Lake. Under such a view, it can be said that the EfS website promoted action for sustainability in the context of Lanalhue Lake, but such a claim cannot be supported with further details regarding such actions, evidencing a limitation of the present study to assess this key aspect with more depth of understanding.

Regarding adoption of sustainable living principles based on revisits, Q7 of the follow-up survey asked participants if the website prompted on them the adoption of sustainable living principles, with 14/18 participants indicating 'Yes'. This occurred even with participants in typology Group 3, who were rated as having a low understanding of sustainability issues. This illustrates the capacity of the EfS website to promote adoption of sustainable living principles within participants with a low level of understanding of sustainability issues at Lanalhue Lake (for details on other types of adoption in regard to typology groups, please refer to Table 8.6).

When approaching the above findings related to action and to adoption of sustainable living principles from a systems thinking and complexity theory in education perspective, the first interaction between the EfS website

acting as an educational facilitator with participants prompted the emergence of a series of motivations, reported during the post-intervention interviews. These early motivations, in combination with further possible motivations from revisits to the website, appeared to be at the core of subsequent actions and/or adoptions of sustainable living principles, as inferred from participants' reports. In terms of activity theory, this was interpreted as the capacity of the educational activity system defined by the EfS website to present characteristics of an expansive activity system (i.e. third generation activity system) (Cole & Engeström, 2001; Engeström, 2001; Leadbetter, 2005). In such activity systems, the outcomes of an initial activity later become precursors of subsequent activities, forming a network of interrelated and successive activity systems.

Findings also indicated that there was a key component influencing such expansion of the educational activity system into successive activity systems. This key component was the meaningfulness and relevance of the website to participants. There is indication that the more meaningful the EfS website was to participants, the more they tended to interact with it, and to develop further activities from it. Further, there is also indication that such meaningfulness and relevance was not dependent on participants' prior and/or extended levels of understanding of sustainability issues (i.e. pre-, post-, and follow-up typology groups from Chapter 7), but rather on their degree of interest and feeling of connection (i.e. emotional bond) with the lake. Which, in turn, according to activity theory, depends on the socio-cultural background of learners, their individual background, as well as on their experiences, whether based on the website or not. In relation to the concept of arousing emotions, Ballantyne and Packer (2005), citing Boler (1999), highlight that "emotion plays a role as a motivational force in learning, influencing our selection of what we attend to, and what seems important to explore" (p. 288).

In particular, it can be inferred that early motivations from the first visit, and following revisits to the website by participants, prompted some

participants (n = 12/18) to visit the lake during the follow-up period, and see things for themselves. In turn, such a motivational process based on visits to the website that made these participants visit the lake may have contributed to developing emotional bonds with the lake and with the sustainability issues and challenges affecting the lake. Literature from systems thinking and community education (Sections 2.3.2 and 2.5.2 respectively) highlighted that the emotional and affective dimension of learning could be promoted through real-life and locally rooted issues, in turn promoting awareness and meaningfulness and relevance over sustainability issues. This emotional bond aspect was included within the design and development of the EfS website, promoted through considerations such as challenging beliefs of participants by means of the 'evidence, effects and efforts' approach (Ballantyne, Fien & Packer, 2001), and by including relevant, locally rooted, and meaningful issues to participants.

The key point highlighted in this discussion is that, within an activity theory perspective, evidence suggests that the expansion of the educational activity system defined by the EfS website into further activities, which may include action for sustainability, is dependent on the levels of meaningfulness and relevance achieved for participants through the EfS website. In turn, such levels of meaningfulness appear to be dependent on the degree of interest and emotional bond associated with the sustainability issues affecting the wellbeing of the Lanalhue Lake, rather than to prior levels of knowledge (i.e. typology groups from Chapter 7). The implications of such claims are addressed in Section 9.5 of the present chapter.

Having discussed the findings associated with the four research sub-questions, the following section presents the main conclusions from this study, in regard to the use of ICT websites for community EfS in the context of Lanalhue Lake in Chile.

9.3 Conclusions

Based on the evidence obtained from the findings, and having discussed these in relation to the four research sub-questions addressed in the previous section, the following seven conclusions can be drawn from this study. Note that all conclusions are linked to the use of an EfS website for community education in the context of the socio-ecological sustainability at Lanalhue Lake in Chile.

1. A theoretical model enabled the production of an effective EfS website.

   The set of theoretical ideas and considerations drawn from the literature that informed the model for the development and use of the EfS website at the community level was effective in producing the expected educational outcomes of promoting understanding and action around socio-ecological issues. Such EfS related processes are said to empower community members towards sustainability, in the context of the Lanalhue Lake in Chile. In this sense, in general the theoretical model was found to be effective in terms of informing the design and development of such type of EfS websites.

2. The EfS website was a meaningful educational ICT learning tool at the community level.

   The achievement of socio-cultural meaningfulness and relevance can be critical to the success or failure of ICT-based educational interventions at the community level. In this context, the level of interest, connection, and emotional bond with the socio-ecological sustainability issues at Lanalhue Lake can determine the degree of meaningfulness achieved for community members through the EfS website. As discussed in the previous section, different theoretical considerations were aimed at providing such meaningful and relevant experiences. For example, the EfS website Lanalhue Sustentable can be a meaningful educational ICT learning tool by:

   - Effectively addressing the characteristics and needs of the target community over time, offering not only meaningful affordances to the variety of learning backgrounds existing in the target

community, but also to the same user in different possible contexts of use of the EfS website.

- Providing meaningful affordances for the target audience, through the effective understanding of the socio-cultural characteristics and needs existing within the context of Lanalhue Lake. In addition, some learning strategies highlighted in Table 3.4 were said to contribute to this process, for example, understanding and challenging learners' beliefs, and arousing emotional experiences through relevance and meaningfulness.
- Reaching learners presenting low levels of interest and connection with the target sustainability issues by highlighting the existing relationships between socio-cultural sustainability issues present at Lanalhue Lake with other broader and related sustainability issues common to Chile

3. The use of the EfS website promoted understanding of socio-ecological sustainability issues amongst local community members.

The use of the EfS website *Lanalhue Sustentable* promoted the understanding of socio-ecological sustainability issues at the community level, in the context of the Lanalhue Lake in Chile. For example, evidence indicated that the use of some ICT features and affordances, such as multimedia, assisted the learning process related to socio-ecological sustainability issues. Other ideas and considerations from the theoretical model were also found to facilitate such an understanding process, such as the 'knowledge integration' and 'positive communication' learning strategies, or the maximization of affordances to make the website more friendly, accessible, and thus relevant to learners.

4. The use of the EfS website promoted action for socio-ecological sustainability, and the adoption of sustainable living principles and practices amongst local community members.

The use of the EfS website *Lanalhue Sustentable* promoted action, and also promoted the adoption of sustainable living principles and

practices amongst local community members. A highly relevant and meaningful EfS website was critical to reach such outcomes, in the context of Lanalhue Lake. A key aspect related to promoting action was the issue of providing motivational experiences for learners early during the first visits to the EfS website. In turn, such early motivations were found to be related to the relevance of the EfS website to local community members.

5. The theoretical model for developing EfS websites failed to recognize the need to set an administration team to keep the EfS website *Lanalhue Sustentable* up-to-date over time.

Although this issue was highlighted by members of the design team, because the design and development of the EfS website Lanalhue Sustentable was focused on evaluating the effectiveness of the theoretical model, and because the model did not include this aspect, no administration team was set up to keep the website updated. This limited findings in relation to the dynamism of the educational system underpinned by the website, in terms of further promoting learning based on new information, or on upgrades done to the website. However, such evaluation of the dynamism of the website over time would have required a more longitudinal research design over time, as well as the maintenance of an administration team, both being time and resource demanding.

In addition, during the design of the EfS website, it was asserted within the design team that such an administration team would ideally be from the local community, but as indicated in Chapter 5, expertise within the local community was not found in terms of website design and development. Thus similarly, no competent members of the local community were known to be in a position to integrate into such an administration team. Finally, note that the EfS website *Lanalhue Sustentable* has been updated and upgraded since its first version, but such changes were not part of the research design and data collection phases. Similarly, a Facebook administration team was set up for the

Facebook page of the EfS website, which to date still exists, providing to this Facebook page constant input and upgrade of new information related to the sustainability of the lake. But as with upgrades to the website, the impact on social learning based on upgrades to the Facebook page were not evaluated and considered as part of this study.

6. The EfS website facilitated education at the community level.

From a systems thinking and complexity theory in education perspective, the practice of education at the community level occurs within dynamic, unpredictable and complex systems (Capra, 2005b; Morrison, 2002; Somekh, 2007; Sterling, 2001, 2005). In this context, the theoretical model for developing EfS websites included a range of ideas and considerations to address such complexity and promote EfS learning at the community level (i.e. as in Table 3.1). In particular, the considerations were to approach the EfS website as an educational facilitator, adaptable to the (changing) conditions of its educational context. This approach seemed to be appropriate, as the EfS website *Lanalhue Sustentable* facilitated education at the community level by:

- Enabling access to information and making knowledge meaningful to community members;
- Providing means for learners to interact, whether with the website and/or between learners (social media affordances). This was aimed at promoting social interaction for social learning, however, as concluded below, insufficient data limited this finding;
- Addressing a range of different backgrounds, conceptions, and learning needs present in the local community in a meaningful way;
- Empowering local community members towards socio-ecological sustainability through the promotion of understanding and action.

7. The EfS website acted as an expansive educational activity system.

From an activity theory point of view, the EfS website *Lanalhue Sustentable,* acting as the mediating tool at the core of the educational activity system, can present characteristics of an expansive activity

system. This means that outcomes of an initial activity involving the use of the EfS website by a community member (i.e. the subject) can become precursors of other subsequent activities. For example, motivations to adopt sustainable practices after the first visit prompted in some participants the adoption of sustainable living practices later. This expansion of the initial activity system can form a network of interrelated activity systems associated with the local, socio-ecological sustainability of Lanalhue Lake. The meaningfulness achieved through the EfS website was found to be a key factor determining the possible expansion of the educational activity system. Evidence indicated that the higher the levels of meaningfulness achieved during the first visits, the broader the range of subsequent interrelated expansive activity systems to which the EfS website can lead.

These conclusions are based on the answers to the research questions addressed in this study, and formulated around the theoretical framework underpinning the present research. In the coming sections, the limitations and implications of findings of the present study, as well as the recommendations for the use of ICT for community EfS are discussed.

9.4 Limitations of the present study

Besides philosophical and methodological limitations discussed in Chapter 4, related to the epistemological standpoint adopted in this study, and the intervention's limitations discussed in Chapter 5, related to the logistics of the data collection phase, there are two further types of limitations present in this study.

The first limitation concerns the chain of assumptions made from the theory to the final findings, interpretation and discussion. This implies that there are many potential places to have validity problems. In the first instance, a group of theoretical considerations from different fields of knowledge were brought together into the model for the development of EfS websites, presented in Chapter 3. The assumption here was that all these considerations would cohere together into a set of guidelines from

ICT, EfS, and community education theory underpinned by a systems thinking approach. Although crossovers from these different fields of knowledge were found, for example the need of promoting critical thinking for EfS was highlighted in literature from systems thinking, EfS and ICT (as discussed Sections 2.2.4, 2.3.2 and 2.4.3), in other cases crossovers were not so evident. As such, although different ideas from EfS, systems thinking, ICT and community education were brought together into a theoretical model, as discussed in Chapter 3, other important ideas were omitted.

Then followed the design and development of the EfS website *Lanalhue Sustentable*. In this phase, the assumptions were that the theoretical considerations could be infused flawlessly into a website, and that data obtained during the pre-design phase (phase 2) provided the necessary information to address the socio-cultural characteristics and needs of the target community. These assumptions were discussed in Chapter 5, which presented the process of implementing theory from the model in a real-life context in Chile, in turn complemented with data collected within the target community, with the expected outcome of developing an EfS website that would bring about EfS related outcomes.

Once this website was ready as the research instrument, the assumption was that it was possible to link aspects of the website with particular pedagogical objectives and/or outcomes. For example, during the design process it was expected that addressing local characteristics and needs of the target community, as discussed in Section 5.3, made the EfS website meaningful and relevant for people of the target community. And, as discussed in Section 9.2, such meaningfulness was at the basis and contributed to different outcomes highlighted in the discussion section of this chapter, like motivations to take action. And from there, the following assumption was that interpretation of data from the findings chapters (Chapters 6 to 8) was valid within the theoretical framework underpinning this study, presented in Chapter 4. In summary, the study is built on a series of successive assumptions, from theory to practice, on which the

final findings are supported, representing a limitation to the validity of the study.

The second limitation of this study relates to the quality of data collected during the intervention phase. The quantitative data from Google Analytics only provided information at the cohort level, without any detail at the individual level. This means that findings obtained from this data regarding the type of use of the website did not account for the particularities of individual participants. On the other hand, much of the qualitative data from this study was based on self-reported data. Such data represents the risk of participants not being trustworthy in their accounts, thus with the possibility of misleading findings through data that is not dependable (Lincoln & Guba, 1985). In the case of this study, it can be argued that this issue was at least partially overcome through steps taken to improve the dependability of qualitative data.

As discussed in Section 4.7 addressing data validity and trustworthiness, data can become more dependable when providing a clear, thorough and thick description of the data collection process, as well as of the context of inquiry. Techniques to achieve dependable data include the full description of assumptions made during the research, as above; the presentation of a clear audit trail of how data was collected, as discussed in Chapters 4 and 5; and through triangulation of data. It is argued here that this research study complies with such criteria to address dependability of data. Full descriptions, audit trails, and evidence of triangulation of data were presented in Chapter 5, in the findings chapters (Chapters 6 to 8), and in this present chapter, where such findings have been discussed. Nonetheless, this does not rule out the possibility of participants having answered in a particular way just to satisfy the researcher, or simply having lied throughout the data collection phase.

In addition, the low number of participants from this study further limits the trustworthiness of self-reported data, particularly in regard to findings obtained from the follow-up phase where only 18/24 participants provided

input. Which, in turn limits the dependability of claims made from this study, as such a small number of participants only represented a small proportion of the local community. Nonetheless, this study tried to achieve depth of understanding over generalizability, as in naturalistic inquiry (see Section 4.3.5), during the evaluation of an EfS website designed for a local sustainability issue in a community in Chile.

Moreover, the evaluation of actions prompted by the EfS website was found to be deficient in terms of assessing the characteristics and details of such actions for sustainability. Actions taken by participants were only assessed in terms of the type of actions taken, based on a list of eleven possible actions provided in the follow-up survey. From a naturalistic inquiry perspective, the failure here was related to the initial aim of trying to assess quantity over quality of actions. This was because the research design aimed to explore different categories of actions, i.e. website-, lake-, and sustainable living-related actions. This approach limited the evaluation of actions in terms of depth of understanding of actions. This means that there is some degree of uncertainty in terms of knowing if actions reported by participants were linked or not to the criteria from the Action Competence framework (presented in Section 8.1).

Similarly, the research focus and research design of this study limited the assessment of theoretical considerations related to providing social networking affordances through the EfS website for promoting social learning. Literature from systems thinking, ICT and community education highlighted the importance of social interaction for social learning. This theoretical consideration was included in the model for developing EfS websites presented in Chapter 3, and was implemented during the design and development of the EfS website *Lanalhue Sustentable*. Nonetheless, such a learning process that could occur between the interaction of learners through Web 2.0 and social media affordances was not considered as a key evaluative aspect during this study, as this was not the initial focus of the research. This limited potentially important findings in this regard, as the use of social media for community EfS appears as an

interesting area of research. This is based on the increase of availability and penetration of social media technology during the last years, for example smart phones and tablets (ITU, 2012, 2013), and on the potential use of social media for contributing towards community EfS.

With consideration of the limitations of this study, the coming section addresses the implications of findings from this study

9.5 Implications of findings

Acknowledging that this study contains a theoretical element related to the development of the model for designing EfS websites, and a practical element involving the evaluation of the use by community members in Chile of an EfS website designed using this model, the implications of the findings from this study can be separated into theoretical and practical implications.

9.5.1 Theoretical implications of findings

Theoretical implications from this study relate to how different considerations from the four areas of knowledge examined here (i.e. EfS, systems thinking, ICT and community education) were brought together into a model for the development of EfS websites for community education. Overall, it appeared that the combination of ideas from EfS, systems thinking, ICT, and community education worked in general terms. Findings from this study provided evidence of the potential of the theoretical crossovers from these areas to contribute to education for sustainability at the community level using ICT tools. These findings can inform the development of theory in the area of the use of ICT for EfS, where attention should be on the full understanding of the crossovers presented here, as well as on other crossovers yet to be explored.

This implies a call for the establishment of multi-disciplinary research teams that include experts from these areas of knowledge who can further develop theory on the use of ICT for community EfS. Such development of theory based on research can in turn inform practice for the effective

design, development and use of ICT tools for promoting ecologically literate communities. Based on findings from this study, it seems that there are different types of crossovers that could be explored further. For example, the use of multimedia animations to promote learning related to sustainability issues. Or the adaptation of the theoretical model to other types of potential educational ICT tools, as for example smartphones and tablets that generally offer advanced Web 2.0 and social networking capabilities.

Another theoretical implication from this study regards the use of activity theory as a conceptual and analytical framework for research in ICT and community EfS. Activity theory helped to link aspects from systems thinking and complexity theory with ideas from community education, ICT and EfS. The representation of the use of the EfS wesbite by community members as an activity system allowed the consideration of complex relationships existing in community-based educational settings. In particular, activity theory permitted to account for the influence that the social context and background can have on individual learners, influencing the final outcomes of the use of the EfS website.

Findings regarding the capacity of the activity system based on the EfS website to present expansive transformations can support the development of theory in this area. The capacity of activity theory to provide accounts on this dynamic aspect related to the use an EfS website for community education is attractive in the sense of providing a framework for sense-making in a longitudinal temporal scale. Understanding of aspects related to the expansive transformation of activity systems underpinned by educational ICT tools can contribute to community EfS by providing guidelines to enhance such processes during the design phase of EfS websites. Such a type of understanding can also inform theory in terms of making EfS websites meaningful and relevant not only for the activity systems based on the EfS website, but also for the range of possible expanded activity systems originating from the initial use of the EfS website by community members.

In another aspect, literature from complexity theory in education emphasises the deliberate creation and nurture of complex educational systems (Sumara & Davis, 1997; Davis & Sumara, 2005). On the other hand, Morrison (2002) argues that in organizational terms, educational systems ought to act as educational leaders and facilitators. In practical terms, these views mean that an EfS website should be regarded as a complex educational system that deliberately unfolds into a collective learning process at the community level, constantly leading and facilitating such a process around EfS objectives. In other words, the functional objective of EfS websites is to be a valid educational facilitator for community members in a relevant and meaningful way over time, by being able to self-nurture in a meaningful way for learners.

In this sense, the autopoietic definition of living systems formulated by Maturana and Varela (1980) (see Section 2.3), which became central to the formulation of the Gaia theory (Lovelock, 1979), focuses on the processes of living organisms rather than on the (organic) structure of organisms. Autopoiesis theory defines living systems as those who can re-produce themselves over time, based on their own set of rules (Maturana & Varela, 1980, 1987; Morrison, 2002; Murray, 1994).

Based on findings from this study, it can be suggested that an EfS website can be seen as an ICT-based autopoietic entity in the form of an educational leader, capable of re-producing itself by means of being constantly upgraded and updated. Some evidence was found in this study to support this view, but at this stage is insufficient. More research and theory developemt is needed to support this autopoietic view of EfS websites, which appears as a potentially interesting niche to explore in future research in ICT for community EfS.

9.5.2 Practical implications of findings

In terms of the practical implications of findings, these can be resolved into one key implication for the practice of community EfS using ICT tools. Based on the findings, discussion and conclusions regarding the effective

use of the EfS website *Lanalhue Sustentable* at the community level, where evidence indicated the promotion of understanding, action, and adoption of sustainable living principles around local socio-ecological sustainability issues, the following can be suggested: EfS websites may be effective in other socio-cultural contexts.

The implication of this for the EfS field is that educators around the world may assist their local EfS programs by adapting the model for developing EfS website in their particular contexts. Based on the evidence from this study, the use of EfS websites in other contexts has the potential to empower the local society towards ecological sustainability. Certainly this would be influenced and determined by a wide range of complex contextual factors coming from different unpredictable dimensions, but the argument underlying this claim is that the model for developing EfS websites considers them as adaptive educational systems capable accommodating to a particular socio-cultural and socio-ecological context.

In support of this argument is that the Chilean socio-cultural context of the EfS website *Lanalhue Sustentable* was chosen after the development of the theoretical model. In fact, at the time of planning the intervention, as the researcher I was evaluating the possibility to carry out the intervention either in Chile or in New Zealand, each representing completely different socio-cultural characteristics. But at the time I was confident that it was possible to effectively design and develop an EfS website at the community level in either of these countries, based on the theoretical model. This study indicates that the application of the theoretical model in a Chilean community was effective, in terms of the EfS objectives. As a personal challenge, now I may need to evaluate such effectiveness of the theoretical model on a New Zealand community.

Having discussed here what the findings from this study suggested and implied in theoretical and practical terms, the following section addresses what could be done with these findings, presenting a set of recommendations for the use of EfS websites at the community level.

9.6 Final recommendations for the use of ICT in community education for sustainability

Based on the scope of findings from this study, and on the discussion made so far in this chapter, some final recommendations follow for the use of ICT in community education for sustainability. These include recommendations to improve the reach of findings of this study, to carry out further research on some aspects related to his study, and for use of EfS websites at the community level.

1. Investigate the factors that can contribute to the promotion of action for socio-ecological sustainability through EfS websites using qualitative approaches.

The action component is central to community EfS, and one of the principal objectives of this study was the assessment of the potential of websites to promote actions for sustainability at the community level. Based on findings presented and discussed in previous sections and chapters, it can be said that EfS websites can promote action for sustainability at the community level, in the context of the Lanalhue Lake in Chile. The theoretical model from this study included the idea of making visible the efforts that were needed to address the sustainability issues existing at Lanalhue Lake, providing practical steps for taking action at different levels. The Solutions section of the website included a range of practical and achievable guidelines to improve the local socio-ecological system, but the assessment of actions carried out by participants was not within the scope of this study. In order to better understand the process linked to promoting action through EfS websites, it is recommended to include more qualitative approaches, such as open-ended interviews, that can provide more in-depth understanding.

2. Further research is recommended into the following aspects of the use of ICT for community EfS:

- ***Self-nurturing capacity of EfS websites through administration teams***: As discussed in the implications section, the challenge for EfS websites is to remain meaningful over time to users. This means that the EfS website approached as an educational facilitator needs to constantly offer new and/or improved affordances to learners that come from a variety of backgrounds and changing socio-cultural contexts. This attribute of EfS websites is related to the notion of self-nurturing of educational systems, in particular, to the capacity of dynamic adaptation to changing conditions of the educational context. To assess this, research is recommended regarding the potential capacity of website administration teams to achieve self-nurturing capacity of educational systems underpinned by EfS websites.

- ***Theoretical considerations to reach low-interest community members***: As discussed earlier, the effectiveness of the EfS website relied on its capacity to offer meaningful and relevant affordances and experiences. In addition, findings indicated that such meaningfulness in the context of the sustainability of Lanalhue Lake was linked to the levels of interest of community members towards the lake. Participants presenting a low interest reported a low achievement of EfS outcomes. Based on that, research is recommended to improve the theoretical model in terms of the ideas and considerations for promoting EfS outcomes with community members presenting low levels of interest over local sustainability issues. In particular, the theoretical idea of linking low-interest community members' backgrounds to sustainability issues addressed through a particular EfS website seems to be promising for engaging these types of learners in meaningful learning. Nonetheless, the idea of satisfying every type of learners' background appears difficult and complex. However, findings from this study suggest that the effective use multimedia features,

especially when arousing emotions in learners through vicarious experiences, can enhance the learning process, and the engagement of learners into sustainability, to the point where such learning may not be possible otherwise. Therefore it is recommended to explore the use of ICT features and affordances, such as multimedia, to reach low-interest community members.

- ***Application of the theoretical model in other socio-cultural contexts***: In order to improve the understanding of the processes associated with the use of EfS websites for community education, further research is needed in the application of the theoretical model in different types of socio-cultural contexts. In particular, it would be beneficial for community EfS practice using websites to identify the factors that facilitate and/or impede the implementation of EfS websites in different cultures than Chile. Such understanding would contribute to making the use of websites for community EfS potentially effective in many socio-cultural contexts.

3. Promote the adoption and application of the theoretical model by EfS practitioners in Chile.

The theoretical model from this study was effective in promoting EfS outcomes in the community associated with the Lanalhue Lake in Chile. This means that this model, or improved versions of it, can potentially be effective in promoting similar outcomes in other communities in Chile, based on the similarities of the socio-cultural backgrounds of such communities. This represents a great potential for the country in terms of addressing the sustainability issues and challenges affecting different communities in Chile. Whether at the government level, NGO level, formal or non-formal educational level, EfS educators and practitioners from these areas need to consider adopting and implementing the model for developing EfS websites at the community level. These types of institutions are the ones that most easily can undertake the design, development, implementation and use of EfS websites at the community level in a feasible way. Such

adoption is recommended in order to address and improve socio-ecological issues existing at the local level of target communities. A personal challenge to myself is to take this model to EfS practitioners in Chile in a meaningful way.

4. Keep updated with ICT technological innovation and development.

One aspect of today's use of ICT in education is that technological innovation and development goes faster than EfS research and practice. As an example, when I started this study, Internet websites seemed the most appropriate type of ICT technology to study at the community level. However, if I had to start this study today, I would do it on the use of mobile technology for EfS, such as smart-phones and tablets. Mobile technology penetration and use is on the rise worldwide (ITU, 2013), and allows taking the ICT-based educational facilitator to different places with more ease than laptops and computers. This would mean that different approaches would be needed in the design of EfS websites to fit the mobile technology format. This illustrates the importance for EfS researchers and practitioners to keep updated with technological innovation and development, in order to maximise the potential and possible outcomes of the use of ICT for community EfS. In particular, it is recommended to take the theoretical model for developing EfS websites further including other types of ICT under its scope, especially mobile-related ICT.

5. Complement the use of EfS websites with non ICT-based instances, as well as within other educational sectors.

One of the key premises of this study is that sustainability issues and challenges are immediate and require action today. This view focused the scope of this study on non-formal education at the community level. However, it is well recognised in the literature that EfS programs not only should focus on non-formal sectors, but in all aspects and sectors of education and society (Sterling, 2001). This implies that aspects of the model for developing EfS websites could be adapted

and be of assistance to the practice of EfS in different educational sectors. Such a task should be carried out by EfS scholars and practitioners, in association and partnership with ICT experts, as experts and practitioners from these two areas are the ones who could most successfully achieve this process due to their understanding of the ICT-and-EfS field.

In addition, another premise from this study is that EfS outcomes could be achieved through the use of ICT technology. However, the problem with this view is that it accentuates the digital divide between ICT literate and non-literate community members. In terms of community EfS this divide represent a problem. On the one hand, the principal aim of community EfS is to reach the larger community. But through ICT-based EfS programs some members of the target community lose the chance to be empowered by such EfS programs. On the other hand, another key aim of community EfS is to promote experiential ecological literacy, meaning to develop ecological literacy in the natural environment, as a way to close the gap between contemporary societies and nature. Some evidence from this study suggested that multimedia features could close such gap by providing vicarious experiences to participants.

Nonetheless, to overcome these and to further expand the reach of EfS websites in the community, it is recommended to complement EfS website-based interventions with non ICT-based instances. This could be done, for example, through community outreach interventions such as public seminars, or outdoor education, or through the use of printed newsletters. Alternatively, it could be achieved by, for example, setting up a physical face of EfS website-based interventions. For example, in the context of Lanalhue Lake, the setting up of an Lanalhue Lake Educational Centre, in the heart of the natural environment of the lake, and including complementary outdoor experiences, is recommended to increase the reach and scope of the EfS website among community members at Lanalhue Lake. The local community through partnership

with local organizations and local authorities, and assisted by EfS educators could implement such a centre.

The above recommendations are aimed at improving the contribution of the EfS website *Lanalhue Sustentable* in particular, and of potential EfS websites in general. As a final statement of this thesis, it is important to recall that ICT technology does not cause improvement of socio-ecological sustainability, but can effectively assist such improvement.

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Appendix A: Instrument for pre-design data collection stage 2a.

Outline of Data Collection questions for phase II

2a. Understanding of community's local, social, and cultural contexts

- What can you tell me about this community?
- What is the history of this community?
- What have been done in regard to…(i.e. various topics) in this community?
- How long has this issue been present in the community?
- What appears to be meaningful for this community? Why?
- What is the level of community networking and integration in this community?

Appendix B: Instrument for pre-design data collection survey 2b.

Assessing existing conceptions related to the Sustainability of the Lanalhue Lake

Please answer the following questions.

1. Which of these age brackets are you in? (Please circle one)

a. 0 – 19

b. 20 – 39

c. 40 – 59

d. 60 +

2. Which area do you live in? (Please circle one)

a. Cañete

b. Peleco

c. Contulmo

d. Lanalhue Lake

e. Other (*specify*): _____

3. How long have you lived there? (Please circle one)

a. 0 – 1 year

b. 1 – 5 years

c. 5 or more

d. First time visitor

e. Frequent visitor

f. Casual visitor

g. Holiday visitor

4. Have you ever visited Lanalhue Lake? (Please circle one)

a. Never

b. Once

c. A few times

d. Many times

e. I live there

5. What is your attitude / opinion towards Lanalhue Lake? (Please circle one)

a. I don't have one

b. I don't like the Lake

c. I like the Lake

d. I love the Lake

Please explain your attitude

_____

_____

_____

_____

_____

6. Do you believe Lanalhue Lake is a 'healthy' environment? (Please circle one)

a. Yes

b. No

c. I don't know

d. I don't care

Please explain your response

_____

_____

_____

_____

_____

_____

7. Please identify one (1) to three (3) environmental problem(s) of the Lanalhue Lake (if you think there are no problems, please go to question 8).

I.

II.

III.

7a. For one of the problems you have identified above, why do you think it is a problem, and what effect does the problem have?

7b. Who or what has caused this problem? Who should be addressing this problem? Why? Please explain.

8. Have you ever wanted to find out information about Lanalhue Lake's health? (Please circle one)

a. Yes

b. No

c. Don’t know / Not sure

d. I don’t care

If yes, please answer the following sub-questions; otherwise please go to question 9.

8a. What kind of information would you like to know?

8b. How would you / did you get that information?

8c. What prompted you to find out such information about Lanalhue Lake?

9. Have you ever heard about the *luchecillo* aquatic plant (*Egeria densa*)? (Please circle one)

a. Yes

b. No

c. Don't know / Not sure

d. I don't care

If *yes*, please explain what you know; otherwise please go to the next question.

Thank you for your time!

Appendix C: Instrument for pre-design data collection survey 2c.

Websites preferences survey

Please answer the following questions.

1. Which of these age brackets are you in? (Please circle one)

a. 0 – 19

b. 20 – 39

c. 40 – 59

d. 60 +

2. Which area do you live in? (Please circle one)

a. Cañete

b. Peleco

c. Contulmo

d. Lanalhue Lake

e. Other (*specify*): _____

3. How long have you lived there? (Please circle one)

a. 0 – 1 year

b 1 – 5 years

c. 5 or more

d. First time visitor

e. Frequent visitor

f. Casual visitor

g. Holiday visitor

4. Please rate your assessment of your expertise / knowledge on the use of computers. (Please circle one)

a. Excellent

b. Very good

c. Good average

d. Poor

e. Non existent

5. Please rate your assessment of your expertise / knowledge on the use of Internet. (Please circle one)

a. Excellent

b. Very good

c. Good average

d. Poor

e. Non existent

6. Do you have access to a computer connected to the Internet? (Please circle one)

a. Never

b. Rarely

c. Sometimes

d. Whenever I need it

7. Are you interested in environmental / sustainability issues? (Please circle one)

a. Not at all

b. a little

c. a lot

d. I don't know / Never thought about it

8. Do you use websites to get information about environmental / sustainability issues? (Please circle one)

a. Never
b. Rarely
c. Sometimes
d. Often
e. Always

9. Would you consider using a website to learn about environmental / sustainability issues at Lanalhue Lake? (Please circle one)

a. Yes
b. No
c. Perhaps
d. I don't know

10. From the following list of sources of information, which one(s) would you prefer as source(s) of information regarding environmental / sustainability issues at Lanalhue Lake? (Please circle your preferred one(s); you may choose more than one)

a. Information from a local council

b. Official / Government information

c. NGO-based information

d. Private sector information

e. Local media information

f. Information from academic literature

g. Experts-based information

h. Traditional / Indigenous knowledge information (i.e. Mapuche perspective)

i. Information based on different perspectives

j. None of above sources of information

k. Other source(s) (please specify): _____

10a. For up to three (3) of the sources you have chosen above, please explain why you prefer such source(s) of information.

Please return the questionnaire now…

After the questionnaire, time to explain participants the purpose of the interview, then show them three different websites: one that represents a Web 1.0 website (i.e. "old school" website), one that represents a Web 2.0 website ("interactive" website), and one that represents a highly animated website. These three sites will be environmental / sustainability / EfS Chilean sites.

a. From the three Websites that I have shown you: Which one do you like the most? (Please circle one)

Website 1 Website 2 Website 3 None

Why? Please explain

b. Please indicate / explain what aspects / features of the chosen Website you like, and why.

11. From the following table, please mark in descending order the five (5) aspects / features that you would like to see in a website addressing sustainability issues in places like Lanalhue Lake. ***(1 = most preferred; 5 = less preferred)***

Website Feature	**Preference**
a. Videos	
b. Pictures	
c. Animations	
d. Diagrams	
e. Text information	
f. Links to similar / related websites	
g. News regarding place and issue e.g. the Lanalhue lake	
h. Links to Facebook, Twitter, and similar networks	
i. History related to the place and issue e.g. Lanalhue lake	
j. Maps of the area e.g. water bodies related to the Lanalhue lake	
k. Comments section	
l. Blog section	
m. Information on 'what to do' / 'where to go' regarding environmental / sustainability issues	
n. Other (please specify):	

Thank you for your time!

Appendix D: Instrument for pre-design data collection stage 2d.

Outline of Data Collection questions for phase II

2d. Understanding of sustainability issue

- Why is this issue present in this community / in Chile? What is the origin of this issue?
- How can this issue affect the wellbeing of a community / of the country?
- What dimensions are involved in this issue? How are these dimensions involved?

Appendix E: Pre-intervention questionnaire (stage 4a).

Assessing the use of Websites for Community Education – Questionnaire

Please answer the following questions

1. Which of these age brackets are you in? (Please circle one)

a. 0 – 19

b. 20 – 39

c. 40 – 59

d. 60 +

2. Please indicate your gender. (Please circle one)

a. Female

b. Male

3. Which area do you live in? (Please circle one)

a. Cañete

b. Peleco

c. Contulmo

d. Lanalhue Lake

e. Other (*specify*): _____

4. How long have you lived there? (Please circle one)

a. 0 – 1 year

b. 1 – 5 years

c. 5 or more years

d. First time visitor

e. Frequent visitor

f. Casual visitor

g. Holiday visitor

5. Please rate the access you have to the Internet. (Please circle one)

a. Whenever I need it
b. Sometimes
c. Rarely
d. Never

6. Please rate your expertise/knowledge on the use of the Internet. (Please circle one)

a. Very good
b. Good
c. Poor
d. Non existent

7. Please indicate where you usually get connected to the Internet. (Please circle one)

a. Home
b. Cybercafé
c. Work
d. Other (*specify*): _____
e. I don't get connnected

8. Do you use websites to get information about environmental/sustainability issues? (Please circle one)

a. Always
b. Often
c. Sometimes
d. Rarely
e. Never

8a. If you do use websites concerned with environmental and sustainability issues, what for do you use them? (Please explain)

_____

_____

_____

_____

9. How often have you visited Lanalhue lake? (Please circle one)

a. Once
b. 2-5 times
c. 6-10 times
d. More than 10 times
e. Never
f. I live there

10. Please rate your *interest* in environmental/sustainability issues at Lanalhue Lake? (Please circle one)

a. High
b. Moderate
c. Low
d. Non existent

11. Please rate your *knowledge* regarding environmental/sustainability issues at Lanalhue Lake? (Please circle one)

a. Very good
b. Good
c. Poor
d. Non existent

12. Please identify any environmental/sustainability issue(s) at Lanalhue Lake that you know of – list up to 3 (*if you think there are no issues, please go to question 13*).

I.

II.

III.

12a. How have you learnt about this/these environmental/sustainability issues at Lanalhue Lake? (Please explain)

12b. What do you think has caused these issues? (Please explain)

12c. Who do you think is responsible for addressing these issues? (Please explain)

12d. How do you think these issues could be addressed? (Please explain)

13. Have you ever done anything to help the environment of Lanalhue Lake? (Please circle one)

a. Yes

b. No

c. I am not sure

13a. If *Yes*, what have you done and why? (Please explain)

13b. If *No*, has anything prevented you from doing things to help? (Please explain)

_____

_____

_____

End of Questionnaire…

Appendix F: Post-intervention interview instrument (stage 4c).

Assessing the use of Websites for Community Education – Post Intervention Interview

a. Appreciation of EfS website by participants

1.What did you think about the website?

2. What aspects of the website did you like/ not like? Why?

3. Are there any aspects of this website that would you change / improve? Why?

b. Understanding and action of sustainability issues

4a. What did you learn that was new from the website?

And/or

4b. Did you learn anything new about environmental/sustainability issues of Lanalhue Lake from using the website?

And/or

4c. Did you / did you not know about that / those particular issue(s) before the use of the site?

5. Has your level of understanding of the sustainability issues at Lanalhue Lake changed after the use of the website?

6. After reading/learning more of the environmental/sustainability issues at Lanalhue Lake have you got any concerns about them? Why/why not?

Back up questions to Q6:

6a. Has your level of concern changed after using the website?

6b. What do you think has caused these issues to occur?

6c. How do you think these issues are connected?

7. Do you think there is anything you can or should do about those issues? If not, who should be responsible for these issues?

8. Has using this website changed your thinking about doing something to address the environmental/sustainability issues present at Lanalhue Lake? If so what specifically has changed? Why/why not?

9. Has using this website changed your thinking about whether you are living in a sustainable way? Why/why not?

Appendix G: Follow-up survey instrument (stage 4d).

4d. Follow-up Survey Questions

Q1. Have you revisited the Lanalhue Sustentable website since your first visit with me?

Yes *No* (Please circle one)

If No,

1a. Has anything prevented you from revisiting the website?

If Yes,

1b. For what purpose have you visited the website again?

1c. How many times you have visited the website since the first time?

(1-3; 4-6; 7-10; 11-13; 15 or more)

1d. How long on average would you spend on the website each time you visit it?

- 1 minute
- 5 min
- 10 min
- 15 min
- 20 min
- More than 20 min
- Don’t know / can’t remember

1e. Which sections of the website have you visited most? *(You can indicate more than one)*

- Lago Lanalhue
- Sustentabilidad
- Luchecillo
- Soluciones
- Preguntas y Respuestas
- Documentación
- Video e Imagen
- Artículos
- Experiencias y Ejemplos
- Cosmovisión Mapuche
- Sitios amigos
- Acerca de este sitio
- Agradecimientos

Q2. Has your level of understanding about the issues related to the **luchecillo** at Lanalhue Lake changed since your first visit to the website?

Yes *No* (Please circle one)

2a. If yes, how has your understanding changed?

Q3. Has your level of understanding about **other issues** related to Lanalhue Lake changed since your first visit to the website?

Yes *No* (Please circle one)

3a. If yes, how has your understanding changed?

Q4. Has the website prompted you to look for more information?

Yes *No* (Please circle one)

4a. If yes, about what?

4b. Where have you found this information?

Q5. Has your **attitude** towards Lanalhue Lake changed since your first visit to the website? (e.g. your attitude towards black-necked swans; your level of concern towards the lake)

Yes *No* (Please circle one)

5a. If yes, how has your attitude changed?

Q6. Have you done any of the following based on your visit(s) to the Lanalhue Sustentable website? (Place a tick in any appropriate box – you may tick more than one):

Action	**Yes**
Visited the lake	
Told a friend about the website	
Visited links shown on the Lanalhue Lake website	
Visited other websites on environmental issues	
Visited the Lanalhue Sustentable website's social networking sites (i.e. Facebook, Twitter, Flickr, YouTube)	
Thought about how you could help improve the lake's environment	
Thought about how you could improve your immediate environment (e.g. at home)	
Spoken or written to any authority about the environmental problem's in the lake	
Taken any other direct action to help improve the lake's environment	
Taken any direct action to help improve your immediate environment (e.g. at home)	
Other *(please specify)*:	

Q7. Has visiting the Lanalhue Sustentable website prompted you to adopt any new sustainable living principles (e.g. recycling, care about the environment, etc.)?

Yes *No* (Please circle one)

If No,

7a. Have you '**considered',** or had the '**intention',** to adopt any new sustainable principle in your life?

Yes *No* (Please circle one)

7b. Has anything prevented you from adopting sustainable living principles? *Please explain*

If Yes,

7c. What sustainable living principles have you adopted? *Please explain*

7d. What has prompted you to make those changes?

Q8. Please summarize what you have learnt from the website.

Q9. Space for a last comment

Appendix H: Codebook (levels 1 and 2).

Level			
1	**2**	**3**	**Theme**
1.000			**Education for Sustainability (EfS)**
	1.05		EfS learning approaches
	1.10		EfS objectives / goals
2.000			**Systems Thinking (ST)**
	2.05		Creation and nurturing of educational systems (facilitates learning process)
	2.10		Learning context (systems' environment)
3.000			**Information and Communication Technology (ICT)**
	3.05		Affordances
	3.10		Website design considerations
4.000			**Community Education (CE)**
	4.05		Social and cultural context and needs (importance of clearly defining and addressing it)
	4.10		Social learning
	4.15		Relevance and meaningful knowledge
5.000			**Activity Theory (AT)**
	5.05		AT principles
	5.10		Activity System components
6.000			**EfS website / Lanalhue System considerations**
	6.05		General Considerations
	6.10		Lanalhue Socioecological System considerations
7.000			**Use of other environmental / sustainability websites (4a#1)**
	7.05		Work needs
	7.10		For general information purposes
	7.15		Recreation
	7.20		No use of EfS websites
8.000			**Lanalhue system issues pre-awareness / understanding (4a#26)**
	8.05		Eutrophication of Lanalhue lake
	8.10		Other Ecological issues in the area
	8.15		Pollution of Lanalhue Lake

Level			
1	**2**	**3**	**Theme**
	8.20		Lack of environmental care
	8.30		Overpopulation of Lanalhue lake's shores
	8.35		Lack of ecological leadership
9.000			**Sources of information about issues at Lanalhue lake (4a#51)**
	9.05		Personal perception / direct experience
	9.10		News / media
	9.15		Experts
10.000			**Cause of issues at Lanalhue lake (4a#76)**
	10.05		Diversity of factors
	10.10		Lack of environmental care / knowledge / awareness
	10.15		Lack of education
	10.20		Anthropogenic origin
	10.25		Natural origin
	10.30		Does not know / Can't answer
11.000			**People / institutions / organizations that should be responsible of addressing environmental and sustainability issues present at Lanalhue Lake. (4a#101)**
	11.05		Government agencies / authorities
	11.10		Community
	11.15		Industry
	11.20		Transversal responsibility (Authorities / community / industries / stakeholders)
12.000			**Ways to address issues at Lanalhue lake (4a#126)**
	12.05		Temporal dimension
	12.10		Political dimension
	12.15		Social dimension
	12.20		Education
	12.25		Environmental dimension
	12.30		Experts knowledge
	12.35		Transversal dimension

Level			
1	**2**	**3**	**Theme**
13.000			**Actions carried out towards the ecological sustainability of Lanalhue lake, prior first visit to the EfS website (4a#151)**
	13.05		Environmental care
	13.10		Communication & discussion
	13.15		Work-based actions
	13.20		Education
	13.25		Sustainable living / principles
14.000			**Reasons and impediments not to carry out actions towards the ecological sustainability of Lanalhue lake (previous to first visit to EfS website) (4a#167)**
	14.05		Insufficient actions done
	14.10		Reasons and impediments
15.000			**Participants' appreciation of the EfS website lanalhuesustentable.cl (4cA#177)**
	15.05		General opinion about the EfS website
	15.10		Particular aspects / components of EfS site
	15.20		Website aspects to change /add
16.000			**Participants' learning / understanding change from use of EfS website (4cB#231)**
	16.05		Learning / improved understanding
	16.10		Thinking shift
	16.15		New motivation / interest (for learning)
	16.20		Did not improved understanding
	16.30		Reflective process about environmental care
17.000			**Participants' motivation to take action, after first visit to EfS website (4cC#302)**
	17.05		Motivation to take action
	17.10		Actions' responsibility
	17.15		Factor prompting motivation
18.000			**Participants' reflection about living sustainably, prompted by EfS website (4cC#346)**
	18.05		Thought about living sustainably
	18.10		Did not think about it

Level			
1	**2**	**3**	**Theme**
	18.15		Reported aspect of living sustainably
19.000			**Miscellaneous / participants' last reflection / comment from survey 4c (4cD#374)**
	19.05		Last comment RE website
	19.10		Last comment RE educational project
20.000			**Re-visit of EfS website (Follow-up) (4d#420); (Follow-up survey 4d)**
	20.05		Impediments to re-visit EfS website
	20.10		Purpose of re-visit
	20.15		Opinion about EfS website
21.000			**Change in understanding over time (4d#440)**
	21.05		Change in understanding
22.000			**Motivation from use of EfS website over time to learn more / get new information (4d#469)**
	22.05		Motivation for new information
	22.10		Sources of new information
	22.15		Motivation for learning
23.000			**Attitudes change towards Lanalhue lake since first visit to EfS website (4d#494)**
	23.05		Care more about lake's issues
	23.10		Care more about personal environment issues
	23.15		Attitude / perspective change
	23.20		No major change
24.000			**Actions undertaken based on visits to EfS website (other than quantitative list from Q6/4c) (4d#509)**
25.000			**Adoption of sustainable living principles prompted by the EfS website (4d#511)**
	25.05		Factor prompting adoption of sustainable living principles
	25.10		Adoption of sustainable living principles
	25.15		Impediments to adoption
26.000			**Summary of learned issues through EfS website (end of survey) (4d#511)**

Level			
1	**2**	**3**	**Theme**
	26.05		Learning acquired
	26.10		Transformative learning (dissonance)
	26.15		Attitude change
27.000			**Last comment from follow-up survey 4d (4d#560)**
	27.05		Last comment RE website
	27.10		Last comment RE educational project
28.000			**Follow-up survey 4d Emails (4d#578)**
	28.05		Actions
	28.10		Actions / motivation prompted by EfS website

Appendix I: Ethical approval.

Dr Chris Eames

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School of Science & Engineering

Te Pūtaiao me te Mātauranga Pūkaha

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To:	Claudio Aguayo
Date:	28 May 2010
From:	Dr Chris Eames
Subject:	Ethics Sub-committee Report on Ethics Proposal

The Faculty of Science and Engineering Human Research ethics sub-committee has considered the amendment to your proposal entitled *EfS and ICT: Use of websites for community education in Chile*

The proposal as attached is approved. If you wish to vary the terms of the approved application in any way, please contact me to request an amendment.

Signed