

EVALUATING ENVIRONMENTAL LITERACY AMONG
SURREY BC SECONDARY STUDENTS

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Abstract

For decades, environmental education (EE) has been underrepresented in the education system, particularly at the secondary school level. By using a survey, this project sought an understanding of the environmental behaviours, attitudes, opinions, and knowledge of 93 Grade 12 students from five secondary schools in the Surrey School District in British Columbia (BC). The participants completed the survey approximately two years after studying Science 10, their last required science course. The BC Science 10 curriculum and the *BC Science 10* textbook were referenced extensively to develop the survey. The results indicated that, although the sample population performed well on some of the knowledge-based items, the participants demonstrated deficiencies regarding some environmental and ecological concepts. This project also highlighted important elements in the history of EE and offers insights into the challenges of developing a survey to assess environmental literacy and the complexities of integrating EE into the secondary curriculum.

Keywords: environmental education, EE, ecoliteracy, environmental literacy, ecological literacy, Surrey School District, BC Ministry of Education, BC Education Plan, secondary students, Science 10, *BC Science 10*

Table of Contents

Abstract	2
List of Tables	5
List of Figures	6
Acknowledgments.....	7
Chapter One: Background.....	8
Chapter Two: Literature Review.....	17
Overview	17
Environmental Education—Initial Proposals and Their Contexts	18
The Concept of Literacy and Its Connection to Environmental Education	23
Foundational Events in the Description and Development of the Goals of Environmental Education and in Defining Environmental Literacy.....	24
Ecological Literacy	27
Ecological literacy in program proposals from professional ecologists.	27
David Orr’s conception of ecoliteracy or ecological literacy.....	29
Development of the Concept of Ecoliteracy	30
Distinctions Among Environmental Literacy, Ecological Literacy and Ecoliteracy	32
Environmental Education and the BC Curriculum	35
Environmental Education in Current BC Curriculum Proposals	39
The Presence of Environmental Education in the BC Science 10 Curriculum.....	44
Curriculum Redesign in Alberta	46
Changes to Science Curriculum in the US.....	48
Canadian Science Literacy Rankings	49
Closing Thoughts	55
Chapter Three: Methods and Methodology	57
Research Questions and Objectives	57
Research Methodology.....	57
Overview of the Research Design.....	58
School District and Participant Selection	59
Details of the Survey Design.....	62
Survey Writers	63
Administration of the Survey.....	64
Analysis of the Survey Data.....	65
Obstacles and Solutions	66
Closing Thoughts	67

Evaluating Environmental Literacy	4
Chapter Four: Results	69
Demographic Information	69
Experiences with Outdoor Environmental Activities	66
Student Environmental Behaviours and Opinions on Environmental Issues	70
Knowledge Items	74
EE in the School Curriculum	84
Chapter 5: Research Findings and Interpretation of the Results	87
General Analysis of Demographic Survey Items	88
Time Spent Outdoors	88
Behaviour and Attitude Items	90
Responses to Knowledge-Based Items	93
Observed Differences between Male and Female Respondents	97
Environmental Club Participants	102
Biology 11 Student Results	103
Limitations of the Study	105
Conclusions and Recommendations	107
Closing Thoughts	112
References	114
Appendix A: Baragar ThemeMap	123
Appendix B: Ecoliteracy Survey	125
Appendix C: Invitation letter	133
Appendix D: Student Consent Form	134
Appendix E: Teacher Consent Form	135
Appendix F: Survey Instructions	137
Appendix G: Results Excel Summary Sheet	138

List of Tables

Table 1 Characterizations of environmental literacy, ecological literacy, and ecoliteracy, including questions for further discussion.....	34
Table 2 Sample Population of Grade 12 Students from the Surrey School District	61
Table 3 Survey Items 1 to 8 with Response Choices and Results in Raw Score Numbers	70
Table 4 Survey Items 9 to 12 with Response Choices and Results in Raw Score Numbers	66
Table 5 Survey Items 13 and 14a with Response Choices and Results in Raw Score Numbers	70
Table 6 Survey Items 15 to 18 with Response Choices and Results in Raw Score Numbers	71
Table 7 Survey Items 19 to 23 with Response Choices and Results in Raw Score Numbers	74
Table 8 Survey Items 24 to 27 with Response Choices and Results in Raw Score Numbers	78
Table 9 Survey Items 28 to 30 with Response Choices and Results in Raw Score Numbers	80
Table 10 Survey Items 31 to 37 with Response Choices and Results in Raw Score Numbers	82
Table 11 Survey Items 38 and 39 with Response Choices and Results in Raw Score Numbers	85

List of Figures

Figure 1. The main steps that were taken in designing the research.....	58
Figure 2. Responses to survey Item 11: “Which of the following outdoor activities have you tried in the past? (Circle all that apply).” Numerical values shown for number of participants.....	68
Figure 3. Results in responses to survey Item 12: “Which of the following outdoor activities would you want to try ? (feel free to rank with a number).”	69
Figure 4. Results in response to Item 16, “How concerned are you about climate change?”	72
Figure 5. Results in response to Item 17: “In 2007, the BC government created targets to reduce greenhouse gas emissions by 2020 by at least 33% lower than the 2007 levels. How likely do you think these targets will be met?”	73
Figure 6. Results in responses to Item 22: “Which country contributes the greatest amount of greenhouse gases per person ?” Comparison between student ranking of country contributions to actual known ranking (Weaver, 2011).	76
Figure 7. This figure shows the actual carbon dioxide emissions per capita for the five countries that were response options for Item 22: “Which country contributes the greatest amount of greenhouse gases per person ?”	77
Figure 8. Responses to Survey Question 39: “How important do you think it is to learn about ecosystems and environmental topics?”	85
Figure 9. Male and female responses to Item 16: “How concerned are you about climate change?”	98
Figure 10. Male and female responses to Item 18, which asked participants their personal views on growing the economy and protecting the environment.	99
Figure 11. Male and female responses to Item 39, “How important do you think it is learn to learn about ecosystems and environmental topics?”	101

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Chapter One: Background

For my thesis topic, I chose to research the subject of ecoliteracy, also referred to as ecological literacy and environmental literacy, although all of these may often be included under the general term of environmental education. As a secondary school educator in the province of British Columbia since 1998, I have been simultaneously concerned with and intrigued by this topic and felt compelled to research students' behaviours, attitudes, opinions and, most importantly, knowledge related to the construct of environmental literacy. Specifically, I chose to evaluate Grade 12 students who were a few months away from graduation in the largest school district in the province of British Columbia (BC). I chose this group for evaluation to determine students' perceptions, opinions, and knowledge as they were on the cusp of leaving the public school system and about to begin living in society as young adults. One of the main reasons I chose this research topic is that in the years that I have spent both teaching and observing students in the BC public school system, I have seen little emphasis in the BC secondary curriculum on environmental education. Several opportunities seem to exist for the exploration of environment-related topics and concepts in the elementary school curriculum, but once students enter high school, which is usually in Grade 8 or 9, few courses are specifically designed to focus on the discussion of environmental topics or to teach ecological and environmental knowledge. My concern is that the behaviours, attitudes, and knowledge students gain during their elementary school years may be lost and replaced by attitudes of indifference and apathy towards the environment. Furthermore, these attitudes may possibly be accompanied by a lack of the development of related knowledge that is essential for them to form opinions and make sound judgements related to environmental issues.

The goal of my research was to determine if BC high school graduates are graduating with at least basic experiences and knowledge of the natural environment, ecology, and environmental topics such as climate change, environmental degradation, and endangered species. Secondary educators strive to prepare students to become engaged young citizens with interpersonal and employability skills so that they can gain meaningful employment or pursue post-secondary education after graduation. At the same time, educators also want them to become well rounded, caring global citizens with social consciences. The school act *Mandate for the School System* (Province of British Columbia [BC], 2014) stated that the “purpose of the British Columbia school system is to enable learners to develop their individual potential and to acquire the knowledge, skills, and attitudes needed to contribute to a healthy society and a prosperous and sustainable economy” (p. D-90). The document described a need for citizens to “develop a sense of social responsibility” (Province of BC, 2014, p. D-91) and be “thoughtful, able to learn and to think critically, and who can communicate information from a broad knowledge base” (p. D-91). Should not understanding ecology and related environmental issues and caring for the environment fit into the Ministry’s definition of a “healthy society and prosperous and sustainable economy” (Province of BC, 2014, p. D-91) and a broad knowledge base require students’ exposure to a variety of environmental education experiences at all ages? I often question that, if people rely so much on the natural world for resources to support the growing economy and the necessities for life, such as clean air and fresh water, then why does environmental education (EE) at the secondary level not have more presence in the BC curriculum?

The BC K–12 school curriculum, as indicated in the *BC Education Plan* (BC Ministry of Education [MoE], 2011), appears to place a lot of emphasis on reading, writing, and math skills and seems to reflect a push towards the presence of technology. The plan does not mention any inclusion of environmental education, which seems ironic given that at the end of the *BC Education Plan* document, a tree graphic—an icon symbolic of nature—is featured to highlight the five main goals of the plan (BC MoE, 2011, p. 8).

I have additional concerns about the way schools are designed and about some of the student behaviours that I have witnessed over the years. I will use the school where I teach as an example. It has a cafeteria that creates a lot of waste in terms of disposable dishes and cutlery, and even some classrooms and hallways do not have recycling bins and some teachers do not appear to promote waste reduction in their classes. The school's common centre court area, where hundreds of students eat, presents an appalling sight at the end of the lunch hour. Tables are littered with garbage and leftover food, and often some students throw recyclables into the general garbage. To make things worse, the school has volunteer lunch staff who clean up after the students. It is not reasonable to expect students to engage in pro-environmental behaviours when many schools are designed to create waste, when teachers do not model green practices, and when the school permits students to behave irresponsibly by creating a culture that essentially allows them to litter.

For several years, I have been the sponsor teacher for my school's Environmental Club. This club has organized school ground cleanups and nature trail walks in a nearby park. A major challenge faced by the club is trying to get other students involved and to participate in such events. Non-club members seem to have little interest in pro-environmental activities, and they

often give the impression that these activities are only for Environmental Club members, not regular students.

By holding bake sales over the course of a year, the club fundraised to raise money to buy some trees to help beautify the front of our school. We managed to buy two Japanese maple trees that were quite costly and planted them in late spring. We arranged for summer maintenance staff to water them over the summer, and they were still standing strong when I returned to work the following September. Unfortunately, just a few weeks later, I arrived to school one morning to find the trees had been chopped up deliberately in an attempt to either mutilate or kill them. Obviously the acts of one or a few do not represent the attitudes of the majority, but it was still upsetting and disturbing to think that there are people out there who would purposefully harm nature in this way.

Another example includes students in my classes who react negatively if they see a bee, fly, spider, or beetle in the classroom and make statements such as, “I hate insects!”—not realizing the web of life connection that all species share. This is not a rare occurrence but something I have observed repeatedly over the years. Some students often want to kill any bug they see and look at me with shock and intrigue when I pick up an insect and carry it outside, as if I have just completed a most odd and extraordinary act.

Nevertheless, notwithstanding these concerns, I also have seen a lot of positive things that give me hope and feed my interest in the topic of ecoliteracy. The Environmental Club students whom I have worked with over the years have participated enthusiastically in club activities such as planning Earth Day events, organizing bake sales to raise money for the World Wildlife Fund, taking part in Science World’s Green Games, and promoting BC Lung Association’s Clean Air

We Share campaign. One year for Earth Day, a student created a trivia game to be played at lunch in the school's densely populated centre court. The boys who participated really enjoyed themselves and became quite competitive. A similar reaction occurs when I recruit students to participate in the club's Earth Day Bottle Toss to help promote recycling. They laugh and have fun; given the right activity and circumstances, it is possible to reach more students.

Last year two of my Grade 12 Environmental Club students took on the task of designing and planting a spring garden for the front of our school. They spent days planning which bulbs and plants to include and even went to a workshop at a local nursery in order to learn some planting tips. The flowers bloomed in the spring, and one of the girls used her advanced art skills to trim a large existing group of shrubs to resemble the face of our school mascot. Her effort turned out beautifully. I was struck by how selflessly these girls participated in their endeavour; they were not looking for praise or recognition and took on this challenge without being asked to do so as an anonymous gift to their fellow grads.

Another reason I am hopeful is that some secondary schools in the lower mainland have created a school culture that promotes sustainable practices. An example can be found in the City of Vancouver at Windermere Secondary, which has a well-established waste reduction program, including school-based composting, and even has a garden to grow some of their own food for the school cafeteria. Students from that school travel to nearby elementary schools—by bicycle—to pick up their compost. Also found in the Vancouver School District are programs such as Trek at Prince of Wales Secondary. This is a semester-long Grade 10 program with a major emphasis on the environment and sustainability and has been in operation for more than three decades. I discovered another example when I delivered my surveys for this research to the five

participating Surrey School District secondary schools. Upon entering the school, I was delighted to learn that one of the schools had a composting program set up by their school custodian.

The survey that I designed for this research required me to become familiar with the BC Science 10 curriculum (BC MoE, 2008) and specifically the *BC Science 10* textbook (Sandner et al., 2008) that all BC Science 10 teachers presumably use. The text contains a major unit on ecosystems entitled “Sustaining Earth’s Ecosystems,” and all BC students are required to take Science 10, which means they should graduate with a core of common knowledge related to ecology and environmental topics. Nevertheless, although the Science 10 curriculum has environment-related topics, these topics may not get sufficient attention by teachers. According to the Science 10 Integrated Resource Package (BC MoE, 2008),

Science 10 is a graduation requirement. It is designed as a four credit course with an estimated 90 to 110 hours of instructional content. This estimate is provided as a suggestion only; when delivering the prescribed curriculum, teachers may adjust the instructional time as necessary. (p. 15)

As teachers are given flexibility and choice when delivering the Science 10 curriculum, there is no guarantee that they will adequately cover all the course material equally. Furthermore, the ecosystems topic may be too brief and isolated to make a lasting impact on the knowledge students will retain in the long term.

In spite of the student successes I have witnessed and described in this chapter, when time is limited I have seen how other priorities take precedence over Environmental Club commitments, which are viewed as voluntary or extracurricular. If students have a test to study for, have other school obligations surface, or simply want a break to hang out with friends, their

follow-through on club commitments has been quite poor. Often great plans never reach fruition or, as the sponsor teacher, I was the one who ended up completing tasks on their behalf.

Environmental club meetings and associated activities are seen as separate and not essential because they are done on the students' time. Even though some secondary schools are out there doing great things, they seem to be the exception and not the norm.

My hope is that EE can be included in such a way that all students experience it as an integral part of their overall education instead of only as an optional or extracurricular activity for a few. My first step in moving towards change in this direction was to design research to examine the basic ecoliteracy of students and to evaluate their attitudes, behaviours and, in particular, their basic knowledge of ecology and environmental issues. For my research, I addressed two main research questions: To what extent are British Columbia's schools developing environmentally literate high school graduates, and its corollary, what steps would improve British Columbia's curriculum so that graduates have knowledge, skills, and attitudes associated with the construct of environmental literacy?

Although my research questions refer to "environmental literacy," originally my research questions contained the term ecoliteracy, and the survey I developed in the fall of 2013 was entitled "Ecoliteracy Survey." However, while writing my literature review, I discovered a key article outlining the distinct differences among ecoliteracy, environmental literacy, and ecological literacy. I came to the conclusion that I, like many people, did not have a firm grasp on the definition of ecoliteracy and that my survey questions were more in line with the construct of environmental literacy rather than ecoliteracy.

The subjects of my research were Grade 12 students from the Surrey School District, the largest school district in BC. I chose this particular population because they are at the end of their public education experience and about to graduate and pursue post-secondary pathways. With this goal in mind, I created a survey that consisted mainly of multiple choice questions that inquired about students' attitudes, behaviours, and knowledge related to ecology and environmental issues. I used the Science 10 curriculum as a base from which to create many of the knowledge-based questions, also referred to as items on the survey, as it is the final science course that all BC students are required to take and because the course includes a unit on ecosystems. I sought to determine if students retain basic ecological knowledge approximately two years after their studies in Science 10.

The thesis is structured as follows: Chapter 2 is the literature review providing an historical overview of EE and examining definitions of ecoliteracy, ecological literacy, and environmental literacy. The second chapter will also describe the recent *BC Education Plan* (BC MoE, 2011) and the draft proposed K–9 Science curriculum as it relates to EE in BC and will also describe curriculum changes currently proposed in the neighbouring province of Alberta. In addition, the chapter will briefly examine proposals concerning the development of science literacy in Canada and the United States (US). Chapter 3 will describe the research methods in detail explaining the choices made to use a quantitative approach in the form of a survey distributed to student participants in paper (hard copy) format. Chapter 3 will also describe how the student participants were recruited and chosen. Chapter 4 will present the survey results whereas Chapter 5 will analyze and interpret the findings, explore patterns within the dataset, and will return to the research questions. The final chapter will also present a discussion of the

broader implications of the research and include the conclusion and recommendations for future actions. The appendices section includes the 2006 Average Income Census for Surrey, the survey, the invitation letter, the student consent form, the teacher consent form, the survey instructions, and a summary of the Excel® spreadsheet for the survey responses.

Chapter Two: Literature Review

Overview

This literature review is framed by the two main research questions addressed in this thesis: To what extent are British Columbia schools developing environmentally literate high school graduates, and what steps would improve the British Columbia curriculum so that graduates have knowledge, skills, and attitudes associated with the constructs of environmental literacy? The chapter begins by discussing main points in the initial proposals and historical development of the construct of EE and continues to describe curricular concepts that are related to or generally consistent with the goals proposed for environmental education. Included is a discussion of the concepts of environmental literacy, ecological literacy, ecoliteracy, and education for sustainable development (ESD).

The next section of the chapter discusses the position of EE within current proposals for change and revisions to the BC K–12 public school curriculum. Comparisons are also made between the curriculum change proposals for the BC K–12 curriculum and similar efforts underway in the neighbouring province of Alberta. The chapter explores briefly the relationship between science literacy and environmental literacy. Also discussed are recent initiatives to determine the status of science literacy among students in a selection of countries within the Organization for Economic Development and Cooperation (OECD) and recent proposals to develop a common framework for science education across the US with note of the position of EE within general science.

Environmental Education—Initial Proposals and Their Contexts

The development of EE reveals a history of proposals for programs of education and instruction, largely seen as being operated by formal institutions of education: schools, colleges, and universities (M. McClaren, personal communication, January 7, 2015). In short, EE has generally been proposed as an element of the curriculum offered by schools. Historically, the role of public schools in providing a basic general education has often been the subject of debate (M. McClaren, personal communication, January 7, 2015). The best-known and often proposed popular description for the core curriculum of public schools is that it should be comprised of the 3Rs: reading, writing, and arithmetic. Debates over the content of curriculum and teaching methods in these core subjects are still common in the public education systems of Canada, the US, and in other nations (M. McClaren, personal communication, January 7, 2015). Nevertheless, over the final decades of the 20th century and into the 21st, the curriculum of public schools in particular has been expanded to include subjects such as humanities, information technology, gender studies, social justice, modern languages, performing and visual arts, First Nations studies, business education, accounting, and entrepreneurship.

Environmental sciences, environmental studies, and outdoor recreation can also be found in some Kindergarten to Grade 12 programs. Nevertheless, it is not the intent of this review to provide a description of the history of how the overall K–12 school curriculum has changed in Canada and the US since the 1940s. Curriculum changes frequently reflect the shifting expectations of society, often expressed politically, which are concerned with the roles of schools and the nature of what constitutes a general education. *A Place Called School* (Goodlad, 1984), a landmark study of U.S. public schools, included a chapter concerning public expectations

entitled, “We Want it All.” Goodlad’s (1984) study clearly revealed the widening scope of public expectations about the functions and purposes of schools. There is little to suggest that this general trend has since reversed or weakened. EE might be seen as an element of the trend to widen the field of the public school program. EE still maintains a relatively small presence compared to other subjects, especially at the secondary school level. Environmental sciences, environmental studies, and outdoor recreation can also be found in some Kindergarten to Grade 12 programs.

The origin of term “environmental education” is often attributed to William B. Stapp. According to Michigan University’s (2001) news release, upon his death, Stapp was a professor at the University of Michigan and had also taught in the public schools of Ann Arbor, Michigan. Stapp was the first chief of the United Nations Educational, Scientific and Cultural Organization’s (UNESCO) EE section, and he was involved in the planning of the first Earth Day in 1970 (University of Michigan, 2001). In 1969 Stapp published a paper titled “The Concept of Environmental Education” in the newly launched journal, *Environmental Education*. A year later, he published a somewhat expanded version of the original paper, under the same title, in a widely distributed and established journal, *The American Biology Teacher* (Stapp, 1970). The two articles are generally seen as starting points in proposing EE as an element of school curricula. In his early papers, Stapp proposed that EE should have the following four key objectives.

1. Development of a clear understanding that humans are an inseparable part of a system, “consisting of man, culture, and the physical environment” (Stapp, 1969, p. 34) and that man has the ability to alter the interrelationships of this system;

2. Development of a broad understanding of natural and human made environments;
3. A basic understanding of environmental problems, their solutions, and the responsibility of citizens and government to help solve them; and
4. Development of attitudes of concern towards the biophysical environment so that citizens would be motivated to problem-solve.

Stapp's proposal has essentially framed all subsequent descriptions of curriculum focused on the environment. His proposal is noteworthy because of his call for the development of systems thinking and the idea that EE encompassed not only the physical environment but also humans' relationships to it and the role of culture in environment-human relationships, as was seen in the first objective. This idea was extended by Objective 2 that called for the development of understanding of natural and human-made environments. Objectives 3 and 4 included a clear action component into Stapp's proposals by offering that understanding should provoke citizens and government to help solve environmental problems and not only develop concern about the biophysical environment but also drive a motivation to problem solve. It should be noted, however, that Stapp did not use the terms environmental literacy or ecological literacy in his foundational proposal. The origin of environmental literacy is attributed to a paper published by C. E. Roth in 1968 in the journal of the *Massachusetts Audubon Society*, which appeared prior to Stapp's description and definition of EE.

These early foundational conceptions of EE defined it as being multi- or interdisciplinary, combining both the physical and natural sciences with an appreciation of the importance of human culture and human-built environments. Furthermore, from the beginning, EE descriptions had an orientation toward citizenship and the development of the motivation to take responsible

actions to solve environmental problems (Hungerford & Peyton, 1980). These defining concepts have since driven the development of many EE curricula (McBride, Brewer, Berkowitz, & Borrie, 2013) and also provided rich ground for critics of EE who characterized it as being radical, promoting activism, or offering unbalanced criticism of economic development (Sanera & Shaw, 1996).

Stapp's significant contributions to the early definitions and development of EE as a curricular construct are widely recognized and are frequently referenced. It is also important to look at how the broader context in which Stapp's ideas were distributed and recognized, ultimately affected his work in the first place. The 1960s were an active decade in terms of raising public awareness of environmental issues, especially in the US. For example, Rachel Carson (1962) published her highly influential book on the widespread misuse of pesticides, *Silent Spring*, which is often seen as a catalyst for the modern environmental movement. In the same period, issues such as water pollution and acid rain received substantial news coverage. Further, in the US, major political figures were taking note of the public concerns related to environmental issues and were initiating legislative actions. As a result, in 1970, President Nixon addressed Congress with these words:

It is also vital that our entire society develop a new understanding and a new awareness of man's relation to his environment—what might be called “environmental literacy.” This will require the development and teaching of environmental concepts at every point in the educational process. (Council on Environmental Quality, 1970, p. 21)

The use of the term environmental literacy in Nixon's address is significant, although the term appeared in other writings before that (Roth, 1968). Also in 1970, the U.S. Congress passed

the Environmental Education Act, which defined EE as “the educational process dealing with man’s relationship with his natural and manmade surroundings, and includes the relation of population, conservation, transportation, technology, and urban and regional planning to the total human environment” (Environmental Education Act, 1970, p. 1). Notable in this description was the inclusion of both “natural and manmade surroundings” (p. 1) in the field of EE and the implication that EE would be interdisciplinary with topics of “population, conservation, transportation, technology, and urban and regional planning” (p. 1) and their relations to the “total human environment” (p. 1). To this day, the Environmental Education Act—currently known as National Environmental Education Act of 1990—is evidence of responsible governmental action, at a national level, in regard to the need for environmental education. There is no comparable environmental education act that exists in Canada.

The goal of this review is not to provide a detailed history of the development of EE as a curricular concept. Nevertheless it is useful to offer the reader an overview of some of the ways in which the concept was developed following the initial conception offered by Stapp and his colleagues. McBride, Brewer, Berkowitz, and Borrie (2013) provided an excellent review of the concepts of environmental literacy, ecological literacy, and ecoliteracy. In the title of their article, the authors asked, “What do we mean and how did we get here?” McBride et al. made the point that educators are having ongoing discussions in an attempt to clarify differences among these terms and to provide “complete, pedagogy-guiding, and broadly applicable frameworks for these ideals, allowing for standards and assessments of educational achievement to be set” (p. 1). McBride et al. made note that some writers have characterized these discussions and debates about the differences in describing these literacy terms as being of little value because they have

been used in so many different ways and often interchangeably. McBride et al. concluded that, in fact, major areas of agreement exist among the different schools of thought and threads of commonality that run across the various definitions. With those claims in mind, and given the topic and goals of this thesis research, I provide a summary of the major, broadly recognized current definitions of the terms environmental literacy, ecological literacy, and ecoliteracy in addition to some growing trends in the broad field of EE as a curricular construct. In doing this, I have relied extensively on McBride et al.'s synthesis because it is based on a thorough review of important writings and events in the history of the development of the concept of EE.

The Concept of Literacy and Its Connection to Environmental Education

The term literacy is often seen as a major goal of a broad education and an important component of environmental education. The term literacy has generally been defined in dictionaries as: (a) the ability to read and write, and (b) knowledge that relates to a specified subject (Literacy, 2015). McBride et al. (2013) claimed that today's broader understanding and application of literacy has essentially developed from the latter definition. Literacy can be seen as both a cause and an effect in an educational process or curriculum. That is, in order for someone to achieve the second definition of literacy, they must first be a literate individual possessing the ability to read and write. In the context of this thesis, EE can be seen as a curricular means to attaining environmental literacy.

Many of the important events in the development of EE focused on the definition of the goals or outcomes that should result from EE (M. McClaren, personal communication, January 7, 2015). These formative events focused less on the pedagogical means by which these outcomes were to be achieved or developed (M. McClaren, personal communication, January 7, 2015). Of

course, the field of EE consists of many examples of curricula including both goals and outcomes that describe the means, as well as learning experiences, learning environments, and teaching methods, by which the outcomes are to be achieved. A strong example of this would be Project WILD, which is a well-known curriculum project addressing the field of wildlife and habitat conservation (Council for Environmental Education, n.d.).

Foundational Events in the Description and Development of the Goals of Environmental Education and in Defining Environmental Literacy

Following Stapp's initial proposal of EE and the implementation of the U.S. Environmental Education Act, the United Nations (UN), through UNESCO and in conjunction with the UN Environment Programme (UNEP), initiated a series of conferences. The intention of these conferences was to discuss environmental issues on a global scale and to consider appropriate actions to address these problems, including several proposed educational initiatives. Subsequently, in June 1972, the UN Conference on the Human Environment was convened in Stockholm, Sweden, and issued a declaration from the 21st Plenary Meeting of the UNEP, June 16, 1972 (United Nations Environment Programme [UNEP], 1972). Included in the *Stockholm Declaration* was Principle 19, which stated:

Education in environmental matters, for the younger generation as well as adults, giving due consideration to the under-privileged, is essential to broaden the basis for an enlightened opinion and responsible conduct by individuals, enterprises, and communities in protecting and improving the environment in its full human dimension. It is also essential that mass media of communications avoid contributing to the deterioration of the environment, but on the contrary, disseminate information of an educational nature,

on the need to protect and improve the environment in order to enable man to develop in every respect. (UNEP, 1972, para. 29)

Although the *Stockholm Declaration* and Principle 19 did not directly contain the terms environmental education, ecological education, or environmental literacy, it did prescribe education “in environmental matters” (UNEP, 1972) as a means to address environmental problems and issues. The Stockholm Conference set the stage for a series of international meetings and conferences that were important in further developing the ideas of EE and in extending the concept as having international scope. The best known of these foundational meetings are the Belgrade Workshop of 1975, which issued *The Belgrade Charter: A Global Framework for Environmental Education*, and the UNESCO-sponsored Intergovernmental Conference on Environmental Education, held in Tbilisi (in the former Union of Soviet Socialist Republics) in October, 1977. The *Belgrade Charter* opens with the following words: “Our generation has witnessed unprecedented economic growth and technological progress which, while bringing benefits to many people, have also caused severe social and environmental consequences” (UNESCO, 1975, p. 1). The 1977 conference issued the *Tbilisi Declaration*, which was described as a recommendation for “the adoption of certain criteria which will help to guide efforts to develop EE at the national, regional, and global levels” (UNESCO, 1978, p. 2).

McBride et al. (2013) noted that the objectives described for EE at Belgrade and Tbilisi, and in subsequent international meetings, continue to this day to have influence on thinking about the concept of environmental literacy. For example, the major U.S. organization representing environmental educators at all levels—the North American Association for Environmental Education (NAAEE)—maintains a focus on environmental literacy as a goal for

EE curricula (McBride et al., 2013, p. 6). McBride et al. made particular note of the work of Bora Simmons in the development of a set of guidelines for the NAAEE in which she surveyed 21 different frameworks, definitions, and models of *environmental literacy* from a range of different organizations, consortia, and individuals (p. 6). Simmons (as cited in McBride et al., 2013) found that even though there was considerable diversity in the language of these various proposals, there also were significant commonalities. She noted seven major components that were to be found in all the conceptions that she reviewed (as cited in McBride et al., 2013). They were as follows:

- affect;
- ecological knowledge;
- socio-political knowledge;
- knowledge of environmental issues;
- cognitive skills;
- environmentally responsible behaviours (ERB); and
- additional determinants of ERB (Simmons, as cited in McBride et al., 2013, p. 6).

These elements became the basis for NAAEE's (as cited in McBride et al., 2013) *Guidelines for Learning*, which they published in 2000 and 2004. McBride et al. (2013) have used these components as the basis for comparing the frameworks developed around the concept of environmental literacy since Simmons' initial research and made the following claim:

[F]rameworks for environmental literacy proposed over the last several decades exhibit a high degree of similarity and congruence with respect to their major components. All frameworks include knowledge of basic ecological concepts, environmental sensitivity or

appreciation, awareness of environmental issues and problems, and skills and behaviors to prevent and/or resolve those issues as key attributes of the environmentally literate individual. (p. 6)

McBride et al. (2013) applied the acronym AKASA (affect, knowledge, awareness, skills, action) as a shorthand description of the commonalities among these various models of environmental literacy. McBride et al. also noted the consistent thread of developing the capacity for environmental action that runs across a large number of models and program proposals for the development of environmental literacy. McBride et al. charted similarities across 16 programs from 1974 to 2011, including the *Tbilisi Declaration* (p. 11). Their chart is organized across the headings of Affect, Knowledge (which includes ecological, socio-political, and environmental issues as elements of knowledge), Skills, and ERBs. McBride et al. noted, “As reflected in nearly all frameworks, an environmentally literate citizen is an individual who is, most importantly, informed about environmental issues and problems and possesses the attitudes and skills for solving them” (p. 7).

Ecological Literacy

Ecological literacy in program proposals from professional ecologists.

Although it might seem that the terms environmental literacy and ecological literacy are essentially similar and can and have been used interchangeably, McBride et al. (2013) argued that this is a common misconception. In writings about environmental education, David Orr’s (1992) influential book *Ecological Literacy* is often seen as the foundation for the term. This is not the case, however. A desire to differentiate ecological literacy from environmental literacy arose among professional ecologists and scientists during the 1980s and early 1990s as part of a more

general concern about scientific literacy among the U.S. population (McBride et al., 2013). This concern was reflected in the development of major science curriculum projects including Project 2016 that was supported by the American Academy for the Advancement of Science.

Professional ecologists became concerned that misconceptions about fundamental ecological concepts were common in the general public of the US (Munson, 1994) and that a trend to equate ecology with environmentalism was occurring (Krebs, 1999; McBride et al., 2013). From 1986 to 2010, a number of frameworks for ecological literacy have advanced within the field of professional ecology (McBride et al., 2013, p. 13). Included among these are proposals developed by some prominent ecologists including E. P. Odum (1992), whose textbook was a standard for university ecology courses for many years. McBride et al. have summarized the major program proposals regarding *ecological literacy* and have applied the AKASA objectives as an organizing framework (p. 13). The comparison includes eight different programs and shows that in none of these examples is there any significant emphasis on the affect or attitude components, which is a significant difference from programs addressing *environmental literacy*. In the domain of knowledge, however, emphasis is placed on the development of ecological concepts in all the programs that were compared, with less emphasis on socio-political knowledge and, interestingly, on knowledge of environmental issues. Further, only one of the programs listed addresses ERBs.

In summary, proposals for programs of ecological literacy, as developed by professional ecologists, differ significantly in emphasis and inclusions from programs addressing environmental literacy with an emphasis on the epistemology of science and the validation of knowledge obtained through science-based approaches. McBride et al. (2013) claimed that

proposals for ecological literacy developed by professional and academic ecologists view ecological literacy as a subset of environmental literacy, which is viewed in turn as combining ecological literacy and civics literacy (p. 13).

David Orr's conception of ecoliteracy or ecological literacy.

David Orr's 1992 *Ecological Literacy* included foundational work in establishing the development of ecological literacy, as a field distinct from environmental literacy. McBride et al. (2013) noted that Orr often used ecological literacy interchangeably with environmental literacy although they claimed that ecological literacy evolved from the community of professional ecologists and is distinct with a focus on scientific knowledge and ways of knowing.

McBride et al. (2013) have claimed that Orr's concepts of environmental/ecological literacy were strongly influenced by the introduction of the idea of sustainable development as advanced by the World Commission on Environment and Development (1987) in their document called *Our Common Future*—also known as the Brundtland Report—and as extended at the 1992 UN Conference on Environment and Development (Earth Summit/Rio Conference). This UN-sponsored event was significant in proposing and describing the concept of sustainable development and in developing ESD as a replacement for EE and ecological education. A critical document arising from the Rio Conference was *Agenda 21*, especially Chapter 36, which developed a basis for action for education, public awareness, and training being “critical for promoting sustainable development and improving the capacity of people to address environmental and development issues” (United Nations Sustainable Development, 1992, para. 36.3). *Agenda 21* included language that reflects many of the objectives proposed by the founders of EE including awareness, attitudes, skills, and behaviours consistent with sustainable

development and for effective public participation in decision-making. *Agenda 21* also described the scope of ESD as including the physical, biological, and socio-economic environment.

Nevertheless the agenda includes references to human and spiritual development as additional educational objectives. Through the inclusion of the spiritual realm, the language of the agenda indicated a widening of ESD into the domain of ecoliteracy.

McBride et al. (2013) noted the change in emphasis by the UN towards education for sustainable development and away from EE or ecological education. They wrote,

Following these recommendations, UNESCO replaced its International Environmental Education Program (1975–1995) with *Educating for a Sustainable Future* (UNESCO, 1997). As such, the ideology of sustainable development gradually penetrated the environmental education movement and has since asserted itself as a dominant perspective, and even as an educational field in its own right. (McBride et al., 2013, p. 14)

Development of the Concept of Ecoliteracy

Fritjof Capra (1996) introduced the term ecoliterate, when he described it as relating to an understanding of the principles of the organization of ecosystems and the application of those principles for creating sustainable human communities and societies. Similar to sustainable development, ecoliteracy was seen as promoting the idea of using resources in such a way as to ensure availability to future generations. In *The Web of Life*, Capra explained, “Reconnecting with the web of life means building and nurturing sustainable communities in which we can satisfy our needs and aspirations without diminishing the chances of future generations” (2006,

p. 297). Capra also inspired the formation of the Center for Ecoliteracy (2015), which stated on its website,

The best hope for learning to live sustainably lies in schooling that is “smart by nature.” It includes experiencing the natural world; learning how nature sustains life; nurturing healthy communities; recognizing the implications of the ways we feed and provision ourselves; and knowing well the places where we live, work, and learn. (para. 1)

Recently, ecoliteracy has been aligned with the concept of emotional intelligence as proposed originally by Daniel Goleman. Goleman and his coauthors, Bennett and Barlow (2012), have now published *Ecoliterate: How Educators Are Cultivating Emotional, Social, and Ecological Intelligence*. Goleman et al. (2012) proposed five principles that lead to ecoliteracy:

- empathy for all life forms;
- sustainability as a community practice;
- making the invisible visible;
- anticipating unintended consequences; and
- understanding how nature sustains life.

The first principle that leads to ecoliteracy, the ability to feel empathy, “often stems from a deep understanding that humans are part of a broader community that includes all living beings” (Goleman, Bennett, & Barlow, 2012, p. 12). The second principle of embracing sustainability as a community practice is an important part of ecoliteracy because building interconnectedness within one’s community allows its members to work towards a “common good” (Goleman et al., 2012, p. 13) that benefits both humans and other life forms. The practice of making the invisible visible allows individuals to realize that their actions can have far-

reaching effects in other parts of the world, such as burning fossil fuels which contribute to climate change (Goleman et al., 2012, p. 14) or drinking coffee grown by tenant farmers who are paid poorly for their labour and provided with few, if any, supports for effective and sustainable agriculture. The fourth principle of anticipating unintended consequences means that, even if humans try to predict the consequences of their behaviour, they can never fully anticipate the effects of their actions (Goleman et al., 2012, p. 15). The last principle, understanding how nature sustains life, is a key concept because ecoliterate people “have learned from nature that all living organisms are members of a complex, interconnected web of life and that those members inhabiting a particular place depend on their interconnectedness for survival” (Goleman et al., 2012, p. 16). The work of Goleman et al. (2012) clearly continued the discussion of ecoliteracy as a means towards a sustainable future.

Distinctions Among Environmental Literacy, Ecological Literacy and Ecoliteracy

McBride et al. (2013) claimed that a high degree of similarity exists between frameworks for ecoliteracy and those for environmental literacy in that they both include affective, knowledge, cognitive skills, and behaviour components. McBride et al. claimed significant differences exist in the high level of focus on sustainability in the ecoliteracy frameworks and in the introduction of spiritual or holistic elements such as spirit, reverence for the Earth, and expansion of the soul. As McBride et al. put it, advocates for ecoliteracy proposed “An ecoliterate person is prepared to be an effective member of sustainable society, with well-rounded abilities of head, heart, hands, and spirit, comprising an organic understanding of the world and participatory action within and with the environment” (p. 14).

McBride et al. (2013) summarized their overall analysis of environmental literacy, ecological literacy, and ecoliteracy and compared these constructs according to their dominant educational objectives, primary pedagogical approaches, and example strategies (p. 16). Table 1 shows a reproduction of the original Table 8 from the McBride et al. article. This is a helpful synthesis that makes it easy to see the commonalities among the three major strands of curricular thinking and also their areas of difference. McBride et al. concluded their analysis by raising three important questions for the consideration of advocates for the three different literacies.

For environmental literacy-focused programs, questions were raised as to whether these programs must be fundamentally oriented towards problem solving, whereby the environment is viewed as a problem or set of issues. Further, McBride et al. (2013) question the range of appropriate environmental values, who should determine them, and whether environmentally literate people could reasonably disagree with respect to issues requiring significant trade-offs when it comes to problem solving.

In regard to ecological literacy, McBride et al. (2013) noted that these programs tend to be focused on the environment as an object of study and as a system. The question raised is whether the scientific method is a necessary and sufficient way to understand environmental realities and whether the scientific method drives these programs to search for the best or right answers. Further, they ask, can a person be considered to be ecologically literate without being environmentally literate and vice versa (McBride et al., 2013).

Table 1

Characterizations of environmental literacy, ecological literacy, and ecoliteracy, including questions for further discussion

General conceptions of environment	Dominant educational objectives	Primary pedagogical approaches	Examples of strategies	Questions for further discussion
Environmental literacy <ul style="list-style-type: none"> • Problem • Field of values 	<ul style="list-style-type: none"> • Develop problem-solving skills, from diagnosis to action. • Develop a system of ethics. • Adopt environmentally responsible behaviors. 	<ul style="list-style-type: none"> • Cognitive • Pragmatic • Affective/Moral 	<ul style="list-style-type: none"> • Case study, issue analysis, problem-solving project. • Analysis and clarification of values, criticism of social values. 	Must environmental literacy be fundamentally oriented toward problem solving? What is the range of environmental values appropriate for environmental literacy, and who should determine them? How can we recognize that environmentally literate individuals may reasonably disagree with respect to issues requiring significant trade-offs?
Ecological literacy <ul style="list-style-type: none"> • Object of study • System 	<ul style="list-style-type: none"> • Acquire knowledge of ecological concepts and principles. • Develop skills related to the scientific method: observation and experimentation. • Develop systems thinking: analysis and synthesis. • Understand environmental realities in view of informed decision-making. 	<ul style="list-style-type: none"> • Cognitive • Experiential 	<ul style="list-style-type: none"> • Observation, demonstration, experimentation, research activity. • Case study, environmental system analysis, construction of ecosystem models. 	Is the scientific method a necessary and sufficient way to understand environmental realities, or is it imposing a quest for <i>the</i> right answer? In practical terms, is ecological literacy different than environmental literacy—perhaps a subset as Berkowitz et al. (2005) suggest? If so, can a person be considered ecologically literate without being environmentally literate, or vice versa?
Ecoliteracy <ul style="list-style-type: none"> • Shared resource for sustainable living • Gaia 	<ul style="list-style-type: none"> • Promote and contribute to economic development that addresses social equity and ecological sustainability. • Develop the many dimensions of one's being in interaction with all aspects of the environment. • Develop an organic understanding of the world and participatory action in and with the environment. 	<ul style="list-style-type: none"> • Cognitive • Pragmatic • Holistic • Intuitive/Creative 	<ul style="list-style-type: none"> • Case study, social marketing, sustainable consumption activities, sustainable living management project. • Immersion, visualization, creative workshops. 	Precisely what is the ecoliterate individual striving to sustain under the aegis of sustainable development, at what level, and over what spatial and temporal scales? How is the ecoliterate person to judge which actions will positively contribute to sustainable development (see also Bonnett 2002)? What roles might intuition, creativity, and spirituality play in enhancing ecoliteracy? Alternately, what are the pitfalls that may be associated with a spiritual approach?

Note. From “Environmental Literacy, Ecological Literacy, Ecoliteracy: What Do We Mean and How Did We Get Here?” by B. B. McBride, C. A. Brewer, A. R. Berkowitz, and W. T. Borrie, 2013, *Ecosphere*, 4(5), 67–87. Reprinted under a Creative Commons Attribution 3.0 Unported Licence

In regard to ecoliteracy, McBride et al. (2013) noted the focus on seeing the environment as a shared resource for sustainable living combined with a holistic, Gaia orientation. Given those terms, they asked precisely what an ecoliterate person is striving to sustain under the umbrella of sustainable development and at what level and over what spatial and temporal scales. Furthermore, they ask what roles might creativity and spirituality play in enhancing ecoliteracy and what drawbacks might be associated with taking a spiritual approach. These are excellent questions for consideration by program designers and curriculum analysis.

Environmental Education and the BC Curriculum

McClaren (2012) defined curriculum as “a sequence of experiences designed to nurture learning” (p. 3). Eliot Eisner (1985) proposed that three types of curricula or elements are at work in all curricula: explicit, implicit, and null. The *explicit* curriculum has intentional objectives in terms of content and the acquisition of explicit learning outcomes. An example of this would be the ecological and environmental topics and concepts that are included in the BC Science 10 curriculum, such as ecosystems, biomes and climate change and the corresponding learning outcomes as developed from the BC Ministry of Education. The *implicit* curriculum deals with the informal components of learning such as teaching style and the learning environment. The last of the three types of curricula is the *null* curriculum that essentially refers to the content that is excluded or missing in the students’ learning experience. For example, if students are seldom or rarely taught about ecology and environmental topics, they may interpret this exclusion to mean that it is not important to learn about such topics as part of their educational experience.

EE could be more integrated into a variety of subjects through both explicit and implicit curriculum; however, for the most part, secondary schools still predominantly organize

curriculum into separate compartments that are not integrated. In “Transformative Environmental Education: Stepping outside the Curriculum Box,” BC educator Julie Johnston (2009) wrote,

It is obvious that time is of the essence, that education must revisit its goals, and that the future of humanity is, to a large part, in the hands of educators. If humanity is to mitigate global warming and adapt to a planet with an unstable climate, we will have to ensure that education be rapidly adaptable, making an immediate shift to transformative environmental education and sustainable development learning. (pp. 150–151)

Johnston is pleading for a different sort of schooling—a curriculum that invites students to think critically about current realities and lifestyles and to consider alternatives to consumerism and the capitalist economic model, both which might be seen as deeply embedded in the implicit and null aspects of current school programs. She suggested that teachers, school administrators, parents, and perhaps the whole community must reconsider what schools intend to accomplish and what constitutes an education. Nevertheless the “immediate shift” (Johnston, 2009, p. 150) she referred to is very ambitious.

Johnston (2009) questioned whether education expressed by a controlled and approved central curriculum could prepare students quickly enough for a world facing environmental uncertainty. She argued that students cannot wait for curriculum committees, reviews, and revisions to occur (Johnston, 2009). The transformation Johnston was seeking is unlikely to happen without the presence and commitment of informed and effective teachers. Furthermore, for a variety of reasons, EE is often found as the null curriculum in many BC secondary schools. In her article, Puk and Makin (as cited in Johnston, 2009) proposed four main reasons to explain why teachers often do not include EE in their teachings: lack of time; lack of resources; lack of

knowledge and comfort in the area of EE; lack of support from colleagues, administration, school board, and parents (pp. 151–152). Nevertheless she stated that these reasons are no longer valid when the state of the world is considered and claimed that teachers have a responsibility to be educated in planetary matters, such as climate change. Johnston asked, “How, then, are we to ‘save the planet’ and all future generations (of all species) as long as environmental education and sustainability learning are stuck in the curriculum box?” (p. 151). Unfortunately this curriculum box that she writes of hardly exists. EE is expected to be forced into an existing, often crowded curriculum, by teachers who are largely unprepared, inexperienced, and possibly unwilling to add anything else to their course content.

Part of Johnston’s (2009) solution involves capable and motivated teachers being creative and making choices by using implicit curriculum through an approach whereby EE topics are infused into their lessons. Some of the teaching methods Johnston implemented to ensure her students learn about the importance of other species and develop an appreciation for nature are bringing the outside inside, place-based learning, and creating teachable moments that involve topics of sustainability and fairness. Johnston’s approach may seem inspiring and impressive; however, for most teachers at the secondary school level, it could prove to be challenging because courses are usually taught in isolation with few cross-curricular opportunities and because the existing curriculum is already crowded with topics to be covered and expectations to be met.

Recent studies have suggested that EE implementation has been a challenge in the province of BC (Caner, 2009; Robertson, 2007). Robertson (2007) sought the views of environmental educators from both the formal and informal sectors with regard to the bridges

and barriers associated with implementing EE in BC. His research revealed that a diverse group of practicing BC educators, resource developers, administrators, and community members have been engaging in EE practices and also that an abundance of readily available, quality learning resources and classroom programs related to EE exist in BC. Robertson also cited the Environmental Educators Provincial Specialists' Association as playing a significant role organizing EE initiatives in BC during the last two decades. Robertson's participants provided insights into the personal, curricular, institutional, and policy (governmental) bridges and barriers that environmental educators encounter when trying to implement EE practices (Robertson, 2007).

Some of the personal bridges that were highlighted in Robertson's (2007) study included personal experience, background knowledge, and self-motivation. Robertson (2007) cited the following as examples of curricular and institutional bridges: well-linked resources; quality programs; collegial, administrative, and community support. Existing curricula and funding were examples of governmental bridges. The personal barriers that participants encountered were lack of background knowledge and motivation and "champions fatigue" (p. 75). Curricular barriers included lack of time and curricular fits, a focus on exams, lack of resources, and liability factors. Among the institutional and governmental barriers were low collegial and administrative support, limited teacher education program, low community support, lack of funding, a focus on exams, and low government support (Robertson, 2007).

Another recent study related to the challenges of EE implementation is that by Caner (2009), which explored the status of outdoor learning in Kindergarten to Grade 12 public school programs in BC. Caner's research identified barriers to implementing outdoor learning

encountered by teachers and administrators. The barriers included insufficient funding, concerns about legal liability, and insufficient time in the school day. Caner's study participants made recommendations that included making the provincial government and school districts more responsible for providing school-based outdoor learning activities and for providing the allocation of funding and resources to support outdoor learning. Participants in the study also suggested that when possible teachers and administrators should allow schoolyards and green spaces to be used for outdoor learning. Teachers and administrators should incorporate outdoor learning into existing curricula, and that teachers should collaborate more with their colleagues to increase outdoor learning (Caner, 2009). Last, outdoor learning providers should learn about the opportunities that exist in the BC curriculum that would permit them to advocate for their programs while increasing collaboration with various BC organizations (Caner, 2009).

Environmental Education in Current BC Curriculum Proposals

Currently a general process of curriculum revision is underway in BC, with a document titled *The BC Education Plan* (BC MoE, 2011) as the framework intended to shape the directions of the revision. The main page of the *BC Education Plan* website proclaimed, "The world has changed . . . the way we educate students needs to continually adapt" (BC MoE, 2011, p. 3). This opening catch phrase sounds progressive and promising, but the plan does not acknowledge how the world has changed from an environmental perspective, nor does it address how to prepare students to face future environmental issues or opportunities or how to become citizens who can affect constructive changes in regard to human–environment relationships (BC MoE, 2011).

In spite of the language about a changed world, the proposals are actually a modernization of a conventional curriculum structure that emphasizes reading, writing, and math skills (BC

MoE, 2011). Furthermore, the plan stated that “students will still be required to meet core learning outcomes” (BC MoE, 2011, p. 4). As a whole, the *BC Education Plan* is quite vague and nonprescriptive and leaves a lot to interpretation. It claimed that it will “give students, families and educators more say on how, where, when and what students will learn” (BC MoE, 2011, p. 5). It further stated that it is “based on a simple principle: every learner will realize their full potential and contribute to the well-being of our province” (BC MoE, 2011, p. 5). This reference to the well-being of our province presents the assumption that students will become contributing members to our BC economy. In particular, the plan highlights the following five key elements:

1. personalized learning for all students;
2. quality teaching and learning;
3. flexibility and choice;
4. high standards; and
5. learning empowered by technology. (p. 5)

The BC K–9 science curriculum is currently under review, and some educators, parents, and individuals who are advocates for EE are concerned that the Plan significantly lacks environment-related content. According to the *Area of Learning: Science Draft Curriculum*, which is available on the BC Ministry of Education (2013) website, Grade 3 Science has a brief unit on ecosystems and food chains (p. 4). In the draft, there is no mention of any topics related to the environment or ecosystems for Grade 8 Science (BC MoE, 2013, p. 12) and the only topics mentioned for Grade 9 Science are related to the carbon and nitrogen cycles (p. 14).

The *BC Education Plan* has been criticized for essentially removing EE from the BC curriculum. The Sierra Club BC’s education team, along with many educators and BC policy

makers, expressed their concern regarding this removal in an article called “Draft Curriculum Shortchanges Students by Cutting out Environment” (Sierra Club BC, 2014). Visitors to the Sierra Club BC website have been encouraged to sign a petition and send their concerns to the BC Education Minister Peter Fassbender. As of April 14, 2015 more than 7800 people have signed it. The preamble to the petition states,

Environmental education tackles the inherent complexities surrounding social, economic, and ecological systems, encouraging children to develop their abilities to innovate, creatively problem-solve, and think critically about local, national, and global issues. These skills are the ones young citizens need to develop as they prepare to face the rapidly changing world in which we live. (Sierra Club BC, 2014)

Kieran Dowling, former education program manager of the Sierra Club BC, noted that the proposed draft curriculum did not take into consideration what today’s world will look like decades from now and that children will have to face big issues such as the depletion of non-renewable resources and the effects of climate change on human and nonhuman species (Sierra Club BC, 2014). Dowling expressed his concerns regarding the curriculum draft that removed words such as habitat, ecosystem, pollution, and sustainability (Sierra Club BC, 2014). In the Sierra Club article, Dowling wrote,

The future of our society, our health, and the environment relies on citizens—young and old—who understand their place in the world and make innovative, responsible choices to maintain a healthy planet for all. Environmental education offers a framework to support a child’s discovery of complex relationships, to develop a sense of responsibility, and to examine their own values and morals. (Sierra Club BC, 2014)

Dowling's article on this public matter was published in *The Vancouver Sun* newspaper, yet it can no longer be found. When I made a request for the newspaper's staff to assist me in locating the article, I received no reply. Fortunately a staff member from the Sierra Club BC sent me the original document. In it, Dowling wrote,

The Sierra Club BC has made a clear statement on their website in regards to the curriculum draft proposals.

Having reviewed Transforming Curriculum and Assessment - Curriculum Draft we the undersigned share grave concerns about the removal of environmental education from the proposed science and social studies curriculum.

Nature education is valuable to the development of young learners. Teaching children about natural systems and helping them to understand the relationship between human activity and the natural world contributes to cognitive development, reasoning, and personal well-being. Additionally, there is growing evidence to support the theory that children learn better and are happier and healthier when provided with educational opportunities outside. (Sierra Club BC, 2014)

Lastly, the Sierra Club BC (2014) has called for changes to the BC Science and Social Studies curricula that would include or emphasize EE. The Sierra Club suggested involving environmental educators to participate in the curriculum¹ design process for these subjects (Sierra Club BC, 2014).

The *BC Education Plan* falls short by excluding any reference to the concepts of environmental or ecological literacy, ecoliteracy, or environmental education, which leaves the

¹ Well-known environmental educator Lenny Ross was added to the committee.

impression that EE is insignificant, optional, or to be included only at the teacher's discretion. In the early months of 2015, however, some changes appear to have been made to the previous K–9 Draft Science curriculum with resulting additional environmental topics and concepts. In the most current version of the curriculum draft (BC MoE, 2015), there has been an addition of more ecosystem and nature-related topics to almost each grade level. For example, Grade 9 Science now includes bioaccumulation, sustainability, and the interaction of abiotic and biotic factors within an ecosystem (pp. 17–18); however, I received this information unofficially as an anonymous personal communication so the status of these revisions is not known.

It should be noted that, in spite of the apparent lack of EE in the proposed K–9 science curriculum, in previous years the Ministry of Education in BC has invested in developing environmental education resources for BC educators. The *Environmental Learning and Experience* (BC MoE, 2007) document and the *Environmental Learning and Experience Curriculum Maps* (BC MoE, 2009) are useful resources that provide BC educators with ways to integrate environmental concepts and learning into their classrooms across a variety of K–12 curricula. The Complexity, Aesthetics, Responsibility, and Ethics framework—also known as CARE—is integral to *Environmental Learning and Experience* document and “demonstrates the interdisciplinary nature of environmental concepts, while showing a progression of the development of ideas that can lead towards deeper engagement with environmental learning in all of its forms” (BC MoE, 2007, p. 11). The *Environmental Learning and Experience Curriculum Maps* were later created to show Kindergarten to Grade 12 teachers where environmental connections exist and how environmental themes can be further integrated into teaching and learning (BC MoE, 2009). The document acknowledged that “teachers adept at

integrating the environment and sustainability into their practice are often well aware of these curriculum links, while others may find the connections less obvious” (BC MoE, p. 7, 2009).

The Presence of Environmental Education in the BC Science 10 Curriculum

In spite of the *BC Education Plan*'s apparent deficiencies in regards to EE, the current BC Science 10 curriculum includes an extensive unit on ecosystems (Sandner et al., 2008). The first unit of the *BC Science 10* textbook, entitled “Sustaining Earth’s Ecosystems,” reflects approximately one quarter of the textbook’s content (Sandner et al., 2008). It includes topics such as biomes, nutrient cycles, bioaccumulation, climate change, ecological footprint, invasive species, the food chain and web, nutrient cycles, human-caused pollutants, pollution, and sustainability. This is the only mandatory secondary course that includes ecological content. Furthermore, there is no certainty that Science 10 teachers will cover the entire unit, and the lessons learned in this relatively short amount of time could vanish if little discussion and reinforcement occurs outside of this one course.

With virtually no presence of EE in the *BC Education Plan*, Science 10 teachers may opt to skip or limit their coverage of the ecosystems unit if pressed for time. Notably, the curricula for Grades 10 to 12 are also part of the overall revision and a separate committee is now looking at Science 10 and the senior science courses. Those committees have only recently been formed as of 2014, and so far no drafts have been released.

The retention of the ecological components of the current Science 10 program is certainly not guaranteed. Studying these ecological topics does not guarantee that students will develop a connection to the natural world nor does it meet a number of the expectations or goals described by the various authors cited above for environmental education. According to Morrone, Mancini,

and Carr (2001), “Environmentally literate individuals are equipped with more than just knowledge about ecology; a completely literate person combines knowledge with values, which leads to action” (p. 34). McClaren and Hammond (2005) have written about research that suggests that the complex relationship between knowledge, values, and actions is not linear or sequential. A person may have knowledge and claim to have values but not act. A person may act with limited knowledge and develop knowledge through action and reinforce or add to his or her set of values.

As EE is only a small portion of their educational experience, many high school students may be given the indirect, or implicit, message that EE does not have an important role in a well-rounded education, thereby becoming a component of a null curriculum (Eisner, 1985). Rather than act as though it is business as usual, educators—along with the support of administrators, parents, and political leaders—could provide all secondary school students with the EE experiences necessary to further develop and strengthen their ecological intelligence and identities. Capra (2005) warned his readers of their responsibility towards future generations when he concluded:

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 . . . It is up to us to learn to apply these principles and create systems of education through which coming generations can learn the principles and learn to design societies that honor and complement them. (p. 29)

Curriculum Redesign in Alberta

When I considered what was happening in the BC curriculum, it seemed important to look at trends in other Canadian provinces where curriculum revisions are also underway. Curriculum redesign is currently (2015) under way for Kindergarten through to Grade 12 in Alberta. *The Ministerial Order on Student Learning* (Alberta Regional Consortia, 2013b) developed the goals and standards applicable to the provision of education in Alberta by highlighting three major descriptors known as “the three E’s [sic]” (pp. 5–6): engaged thinker; ethical citizen; entrepreneurial spirit. The related document, entitled *Inspiring Education: A Dialogue with Albertans* (Alberta Education, 2010), is a compilation of community conversations and hypothetical educational goals and outcomes for future Albertans.

Interestingly, the *Inspiring Education* document features various word cloud visuals created from summaries of the conversations with participants at public forums in various Alberta communities. The following words and phrases were highlighted in a number of these word clouds: “environmental and sustainable” (Alberta Education, 2010, p. 3), “sustain the Earth” (p. 9), “globally aware and locally aware” (p. 9), “environment” (p. 17), and “knows they impact the environment” (p. 29); however, no reference to the role of EE has been made in the *Inspiring Education* document whatsoever. The following was the first EE-related statement that could be found: “A priority of government is to ‘ensure Alberta’s energy resources are developed in an environmentally sustainable way’” (Alberta Education, 2010, p. 12). The second and last example was found in the section that hypothetically described how an educated Albertan might see themselves in 2030: “As a steward of the earth, I minimize environmental impacts wherever I

go” (Alberta Education, 2010, p. 19). Interestingly, the idea of not making an environmental impact at all is excluded.

It was encouraging to read that the *Inspiring Education* model promoted a curriculum that allows for more interdisciplinary learning (Alberta Education, 2010, p. 7) and claimed to be informed by UNESCO’s four pillars of learning—learning to be, learning to know, learning to do, and learning to live together (p. 14). Also the document’s stance that education should be more than just preparing youth for the work force is refreshing (Alberta Education, 2010, p. 18). In the *Alberta School Act Appendix* (Alberta Ministry of Education, 2013), the Alberta education minister at the time, Jeff Johnson,² included a small EE reference under the Ethical Citizen heading: “as a steward of the Earth, minimizes environmental impacts” (p. 3). However, the curriculum redesign does advocate that the educated Albertan of 2030 should possess a number of competencies that include reading, writing, mathematics, technology, languages, media, and personal finance literacies (p. 26). In a fashion similar to the *BC Education Plan*, no mention of environmental literacy, ecological literacy, or ecoliteracy was made in the *Inspiring Education* document at all. Interestingly, of the 28 photographs that are used in the *Inspiring Education* document, 20 are direct references to natural environments, such as children feeding chickens, footprints in the sand, a woman rock climbing, and backpackers hiking in the wilderness. This inclusion of nature-inspired photography, combined with the tag clouds and scarce references to EE may be seen as sending conflicting messages to the reader.

² The Alberta government has undergone a restructure including a new premier in addition to the crash in oil prices that are having an effect on the province’s economy. Education Minister Jeff Johnson, a supporter of the Alberta Curriculum Redesign process, was replaced by Gordon Dirks in September 2014.

Changes to Science Curriculum in the US

In 2013, the United States federal Department of Education proposed significant changes to the science curriculum for Kindergarten to Grade 12. This initiative was sponsored by the National Governors Association and the Council of Chief State School Officers (Eveleth, 2013). These are the first changes to U.S. science standards to occur since 1996 (Eveleth, 2013). Known as the Next Generation Science Standards (NGSS), this new curriculum has been adopted by 26 states, even though it is voluntary for states to participate (Eveleth, 2013). The standards include teaching topics such as climate change and evolution, which Eveleth described as being controversial for some parents (Eveleth, 2013). These standards were created to address the problem that the NGSS (2013a) website described as follows: “The U.S. system of science and mathematics education is performing far below par and, if left unattended, will leave millions of young Americans unprepared to succeed in a global economy” (para. 1). This statement implies that more needs to be done for students to meet the criteria of employment preparedness and sounds similar to the *BC Education Plan*’s notion of contributing “to the well-being of our province” (BC MoE, 2011, p. 5). At the secondary level, in Grades 9 through 12, the NGSS include the following environmental topics: interdependent relationships in ecosystems; ecosystems dynamics, functioning and resilience; biodiversity and humans; human impacts on earth systems; and global climate (Next Generation Science Standards, 2013b). The proposals of NGSS appear to be consistent with McBride et al.’s (2013) descriptions of ecological literacy and environmental literacy, but topics related to ecoliteracy—such as spirituality and social justice—appear to be absent; however, this absence isn’t surprising since such topics would not be expected to be covered in a science standard. This recent change to the American science

curriculum demonstrates a willingness to educate youth about environmental and ecological knowledge. In contrast to the US, Canada's educational responsibilities are determined provincially and territorially rather than federally. The closest Canadian project that set a national vision for science literacy was the *Pan-Canadian Protocol for Collaboration on School Curriculum* (1995), which created a common framework of science learning outcomes for Kindergarten to Grade 12 (Council of Ministers of Education Canada, n.d.).

Canadian Science Literacy Rankings

Although the survey that I have developed for this research included questions related to environmental attitudes and behaviours, the area of focus for the research was environmental and ecological knowledge components. A major goal of my research was to find out what Surrey secondary students know about ecosystems and environmental problems and topics such as climate change and threatened species. Additionally, several of my survey questions were designed to assess students' areas of knowledge specific to BC rather than only general knowledge.

National and international assessment projects have also examined content knowledge and skill areas that include environmental and ecological topics. For example, Programme for International Student Assessment (PISA) assesses the performance of 15-year-old students in the areas of mathematics, reading, and science (OECD, n.d.). Since the year 2000, students from schools randomly chosen worldwide from the 34 OECD countries take the 2-hour PISA exam every 3 years (OECD, n.d.). According to the *PISA 2012 Assessment and Analytical Framework* (OECD, 2013a), scientific literacy is defined as

Scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues; Understanding of the characteristic features of science as a form of human knowledge and enquiry; Awareness of how science and technology shape our material, intellectual and cultural environments; Willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen. (p. 100)

According to the 2012 PISA results, in the category of “science literacy, 15-year-olds [Grade 10] in Canada scored an average of 525 points compared to an average of 501 points for all OECD countries” (OECD, 2013b, para. 1). Canada ranked 10th in the science category, which was lower than the 2006 results when Canada ranked third (OECD, 2013b). It is worth noting that age-fifteen students, in Grade 10, who are taking the PISA exam, may be tested on ecological knowledge. Out of the 11 sample questions available on the PISA website, three questions assess the students’ knowledge of biodiversity in the form of a food web: one question is related to climate change and the human connection to carbon emissions, and two questions inquire about the use of insecticides on flies (OECD, n.d.). Notably, if BC students were to take the PISA exam, it is quite possible that some of them would not have completed the Science 10 ecosystems unit prior to taking the exam. Nevertheless, according to the PISA website, students are not required to have covered certain science topics prior to taking the examinations:

PISA is unique because it develops tests which are not directly linked to the school curriculum. The tests are designed to assess to what extent students at the end of compulsory education, can apply their knowledge to real-life situations and be equipped for full participation in society. The information collected through background

questionnaires also provides context which can help analysts interpret the results.

(OECD, n.d., para. 1)

The above description offers a rationale that is similar to my choice to evaluate the environmental and ecological literacy of Grade 12 students. The survey designed for use in this thesis research project was intended to explore the knowledge students possess related to ecology and the environment as they leave the BC public school education system. A major difference, however, is that my survey was designed for an older age group. I would not expect 15-year olds to be ready to tackle environmental issues and engage in what PISA described “full participation in society” (OECD, n.d., para. 1), but I might expect some 17- or 18-year olds to have begun the path towards engagement.

In an article entitled “Teens Pessimistic about Environment,” the *Toronto Star* newspaper reported that only one in 10 Canadian teenagers believed that issues related to the environment would improve (Brown, 2007). This report was based on the 2006 PISA assessments that included an extensive survey about the environment and related environmental topics. Section 4, Question 22 of the 2006 PISA questionnaire asked students how informed they were about greenhouse gases in the atmosphere, the use of genetically modified organisms, acid rain, nuclear waste, and the consequences of clearing forests for other land use (PISA, 2006, p. 17). The questionnaire also included questions related to air pollution, energy shortages, the extinction of plants and animals, and water shortages. Students were asked to relate how they learned about these topics, to rate their concerns, and to discuss whether they thought these environmental problems would improve or worsen in the future (PISA, 2006, pp. 18–20). For example, Question 24 asked, “Do you see the environmental issues below as a serious concern for yourself

and/or others?" (PISA, 2006, p. 19). Lastly students were asked how much they agreed with the following seven statements:

1. It is important to carry out regular checks on the emissions from cars as a condition of their use.
2. It disturbs me when energy is wasted through the unnecessary use of electrical appliances.
3. I am in favour of having laws that regulate factory emissions even if this would increase the price of products.
4. To reduce waste, the use of plastic packaging should be kept to a minimum;
5. Industries should be required to prove that they safely dispose of dangerous waste materials.
6. I am in favour of having laws that protect the habitats of endangered species;
7. Electricity should be produced from renewable sources as much as possible, even if this increases the cost. (PISA, 2006, p. 21)

According to the executive summary of the 2006 PISA, "73% of the students surveyed said they were aware of the consequences of clearing forests for other land use, 58% said that they were aware of the increase of greenhouse gases in the atmosphere, [but only] 35% said that they were aware of the use of genetically modified organisms" (OECD, 2007, p. 6). The summary also concluded that the better students performed in science, the more they knew about environmental issues; the more they knew about such issues, the more likely they were to feel pessimistic about the future of the environment (OECD, 2007, p. 30).

The issues highlighted in the 2006 PISA questionnaire are all significant and relevant to today's pressing ecological threats. However, it is not certain why PISA does not wait and evaluate students at the end of their compulsory education in Grade 12 (or equivalent) for each OECD participating country. An evaluation of how these students respond once they are in their last years of secondary school might be more pertinent, as they will be closer to the voting age and possibly act upon pressing issues.

In the news media, both the Canadian Broadcasting Corporation (Chung, 2014) and *The Globe and Mail* (Semeniuk, 2014) have reported on the topic of science literacy of Canadians. The Council of Canadian Academies' (2014b) news release announced "Canadians rank highly when it comes to public science knowledge, attitudes, and engagement, finds Expert Panel" (para. 1). In April 2013, the Council conducted a survey of 2004 participants from all of the provinces and territories from the age of 18 years and older. This panel report, *Science Culture: Where Canada Stands* (Council of Canadian Academies, 2014a), concluded that Canadians are excelling in public science knowledge, attitudes, and engagement, but they are lacking in the area of skills development in terms of attaining science, technology, engineering, and mathematics university degrees. For their research, the panel drew on a review of the existing literature on science culture in Canada and overseas, a public survey of science culture in Canada commissioned by the panel, and a record and examination of the organizations and programs that support and promote science culture in Canada. The panel found the following four key findings:

- Canadians have positive attitudes towards science and technology and low levels of reservations about science compared with citizens of other countries (Council of Canadian Academies, 2014a, p. xv);

- Canadians exhibit a high level of engagement with science and technology relative to citizens of other countries (p. xviii);
- Canadians' level of science knowledge is on a par with or above citizens of other countries for which data are available (p. xviii); and
- Canada's performance on indicators of science and technology skills development is variable compared with other OECD countries (p. xix).

For Finding 2, engagement was based on criteria that included interest in scientific and technological discoveries, visits to science museums, petitions signed or demonstrations joined related to environmental issues, and possible donations made by the person for medical research. In Finding 3, the level of science knowledge was based on the panel's commissioned survey, and in Finding 4, performance was based on the results of the 2012 PISA.

These findings indicated that Canadians felt the most comfortable engaging in science related topics compared to other countries and that Canada ranked first in displaying the most interest towards science and technology, with substantial improvements since 1989.

Nevertheless, the Council of Canadian Academies (2014a) stated that the overall results are misleading and that there is still much room for improvement. For example, only 42% of Canadians demonstrated a knowledge base adequate to grasp basic concepts related to scientific issues and debates that are covered in the media (Council of Canadian Academies, 2014a).

Additionally, of degrees attained at the university level in Canada, only 20% of those are in the sciences, and 51% of those who attain degrees in science, technology, engineering, or mathematics have immigrated to Canada, skewing the overall results (Council of Canadian Academies, 2014a). The report also suggested that there is not enough up-to-date data from other

countries accurately assess recent improvements in science literacy (Council of Canadian Academies, 2014a).

Closing Thoughts

The literature reviewed in this chapter provided a useful overview of the origins and meanings of environmental education, environmental literacy, ecological literacy, and ecoliteracy. The work of McBride et al. (2013) was particularly helpful in making a detailed comparison among the three major categories of environment-related curricula. McBride et al. (2013) have found that strong common objectives are shared among many EE curriculum proposals even though they may differ in language and orientation. The questions that were included in the student survey developed for this study may be categorized according to student attention to awareness, knowledge, skills, and actions or environmental behaviours. These categories are reflective of the common themes described across diverse programs by McBride et al. and can also be traced back to the pioneering conceptions of Bill Stapp and the many educators who attended conferences that defined the objectives of EE at Stockholm, Belgrade, Tbilisi, and Rio decades ago.

It is interesting to consider the support provided by governments today in regard to EE as contrasted to that provided by major organizations and governments in the last decades of the 20th century. Proposals such as the *BC Education Plan* include the claim that students need to be prepared for a changing world and for a challenging future, but little or no detailed consideration of developing environmental literacy, ecological literacy, or ecoliteracy exists in these change proposals including the *BC Education Plan*. In spite of almost daily reports about environmental

issues and trends in environmental quality, there seems to be a reluctance by the BC Ministry of Education to take the development of students' environmental understandings seriously.

Chapter Three: Methods and Methodology

In this chapter, I first identify my research questions and objectives, followed by the details of my chosen research methodology. Subsequently I include an overview of my research design in the form of a flowchart highlighting the key steps followed in order to complete my research. Next I provide details about the school district that was the site of my research and about the student population with which I chose to work. Following that, I describe the details of my survey design, the administration of the survey, the process of analysis for the survey data, and a short description of problems encountered and the ways that they were addressed.

Research Questions and Objectives

The research for this thesis addressed two main questions: To what extent are British Columbia schools developing environmentally literate high school graduates, and what steps would improve the British Columbia curriculum so that graduates have knowledge, skills, and attitudes associated with the constructs of environmental literacy? A major goal of the research was to see if the data would provide an indication of the status of environmental literacy among BC secondary school students. My ultimate objective was to bring my findings to those who might help to make any changes that may be needed to enhance the development of environmental literacy, ecological literacy, and ecoliteracy among BC secondary school students.

Research Methodology

For this research, I chose to use a quantitative method in the form of a multiple choice, paper-based survey that also included a few open-ended questions. Because I wanted to survey approximately 100 students from several secondary schools, a quantitative survey was the best option for the research. A survey was designed to assess students' specific ecological and

environmental knowledge. I initially planned to create a web-based survey, but for reasons explained in the last section of this chapter, I had to switch to a paper-based format.

Overview of the Research Design

Figure 1 is a flowchart that was created to highlight the main steps taken to design the research. The timeline begins with the thesis proposal and culminates with the data interpretation and analysis. The process spanned approximately one year and included two leaves of absences totalling four and a half months because of pregnancy and the birth of my child.

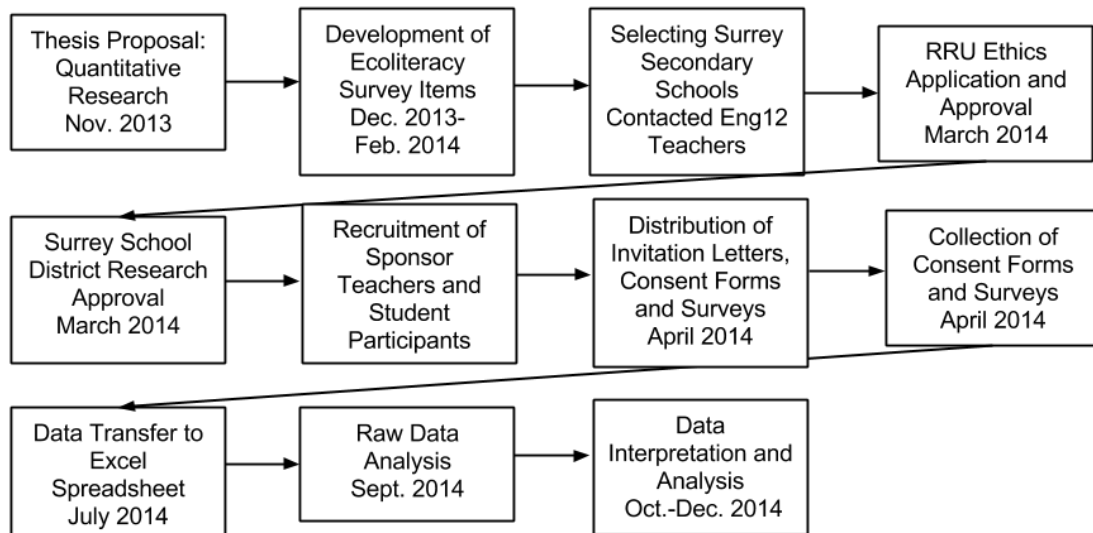


Figure 1. The main steps that were taken in designing the research.

Some overlap occurred in coordinating all the steps. For example, I made initial contact with the school district English helping teacher and English Department heads while I worked on the survey. This due diligence ensured that I had sufficient interest and tentative support from teachers before proceeding to the ethics review. One week prior to submitting my ethics review, I had verbal agreements from five teachers that they would participate as sponsoring teachers once the ethics review from Royal Roads University and Surrey School District were complete. This initial contact and tentative agreement with the teachers expedited the process so that I could

move forward quickly once I received the required approvals over spring break in the third week of March 2014.

School District and Participant Selection

For this research, I chose to work with Grade 12 students from the Surrey School District (SD 36) because I have been employed there as a secondary teacher since 1998 and I know the district well. The City of Surrey is located approximately 25 kilometers east of Vancouver, BC; has a population over 500, 000 (City of Surrey, 2015b); and the school district covers an area of about 328 square kilometers (Surrey School District [SD 36], 2013). The City of Surrey, formally known as The City of Parks, boasts the current slogan, “The Future Lives Here” (City of Surrey, 2015a). SD 36 is the largest in the province of British Columbia and has been continuing to grow (Kilian, 2010). At present Surrey has 101 elementary schools (Kindergarten to Grade 7), 19 secondary schools (Grades 8 to 12), and five learning centers (SD 36, 2013).

The Surrey School District is ethnically and demographically diverse with a wide variety of cultures being represented within the student population. According to SD 36 (2013), *Guide to Schools*, roughly half of Surrey students live in a household in which a language other than English is spoken. Aside from English the most common languages spoken are Punjabi, Hindi, Tagalog, Mandarin, and Korean (SD 36, 2013).

The School District’s mission statement found in the *Guide to Schools* (SD 36, 2013) stated “We engage our students in developing the knowledge, skills and attitudes necessary to build a healthy, democratic and diverse society” (p. 1). Some of the competencies that are highlighted in the district’s vision statement include developing socially responsible citizens and preparing graduates for the future, but no mention is made of environmental literacy or

environmental stewardship in the vision statement. In the 2013/2014 school year, 27,071 students were enrolled in Surrey secondary schools (SD 36, 2013).

Because of Surrey's varied student population, I chose to use a stratified sample of students that would best reflect the various socio-economic demographic areas of the 19 secondary schools in the district. I acquired a ThemeMap, created by Barager Systems Ltd, showing the 2006 average income from the senior research analyst for SD 36 Research and Evaluation Department (K. Peterson, personal communication, November 27, 2013), and I was given permission to reproduce it for my thesis work (see Appendix A). The ThemeMap was a crucial resource to help identify and select the secondary schools for the recruitment of students for my research. Once I coded the map and sorted all 19 secondary schools into one of the five demographic areas based on average income, I made a list of the schools and began contacting English subject department heads for all the secondary schools. Initially I did not receive a response from many teachers, but within a few weeks and after directly contacting both English 12 and Communications 12 teachers and English department heads, I was able to find teacher participants willing to recruit students on my behalf. Fortunately, six teachers from five different schools, with each school representing one of the five demographic areas, volunteered to participate in the study.

From the six English 12 and Communications 12 classes represented by the volunteer teachers, I potentially had approximately 150 students as study participants. A typical secondary school in Surrey has approximately 200 to 300 Grade 12 students. According to Leedy and Ormrod (2013), if the population size is 500, give or take 100, they recommend sampling 50% of the total population (p. 216). Using a proportional stratified sample, I attempted to recruit a total

of 150 students from five different secondary schools and six English 12 or Communications 12 classes. Table 2 shows the breakdown of students per school for this study.

Table 2

Sample Population of Grade 12 Students from the Surrey School District

School	Number of Participants
Region 1	32
Region 2	12
Region 3	18
Region 4	11
Region 5	19
Unknown	1
Total	93

In the end, 93 students participated of which 47 were female and 44 were male; two students left the gender question on the survey blank. It should be noted that by asking for teachers to volunteer from each of the demographic areas rather than seeking eligible participants randomly within each area, a possibility of some bias exists in that the teachers who agreed to participate because they were interested in my research.³ A random selection of potential teacher participants, however, would likely have been time consuming and would require repetition of the invitation and recruitment process until a willing participant was found in each area.

³ Two of the six English teachers indicated to me that they were interested in participating because they wanted their students to have some survey experience as it fit with some of their course objectives. Furthermore, given the constraints of the English 12 curriculum, it is unlikely that these English teachers would have spent time a lot of time covering environmental topics.

Details of the Survey Design

The survey that I created for the research consisted of 40 questions of which 33 were of the multiple-choice format (see Appendix B). The first eight questions on the survey asked students about their gender, the main language(s) spoken at home, their educational history at secondary schools within SD 36 and BC; these questions also asked whether they had taken Biology 11 or 12 and whether they had any affiliation with an environmental club or environmental organization during their secondary school education. These questions were predominantly structured with “yes” or “no” responses, with only two of the eight questions providing for open-ended responses.

Following the opening eight questions, Items 9 through 12 inquired about the amount of time students spent in the outdoors and their participation in outdoor activities, while Items 13 through 18 asked about green practices and environmentally responsible behaviours and attitudes that they had experienced at school, the frequency with which they thought about where their garbage ends up, their concerns about climate change, and their opinion on the BC economy as it relates to environmental protection.

As my research had a focus on the knowledge component of environmental literacy, Items 19 to 37 offered multiple-choice responses to questions about the atmosphere, climate change, BC energy sources, recycling in Surrey, BC species, endangered species, and ecosystems. Thirteen of the 19 knowledge-based questions were developed primarily by using the *BC Science 10* textbook (Sandner et al., 2008) and the BC Science 10 curriculum (BC MoE, 2008). Specifically Items 19 to 27, 33, 34, 36 and 37 were developed based on concepts based on or related to Science 10. I also consulted the book *Generation Us: The Challenge of Global*

Warming (Weaver, 2011). This book, which explained climate change at length, was written by Andrew Weaver, who was a member of the research team that was awarded the 2007 Nobel Prize for science and who was also a reviewer for accuracy for the *BC Science 10* textbook (University of Victoria, 2007). Weaver is also now a sitting member of the BC Legislature for the Green Party (Green Party of BC, n.d.). Please refer to Appendix B to view all of the Survey Items.

In the last two survey questions, Items 38 and 39, the students were asked about their overall opinions on how adequately their high school education covered ecological knowledge and environmental problems and how important they felt it was to learn about ecosystems and environmental topics. The reason that I placed these opinion-seeking items at the end of the survey was because I thought the students would be better equipped to respond to such questions once they had answered and reflected on their responses to the attitude-, behaviour-, and knowledge-based items.

Survey Writers

Four Grade 12 students and one Science teacher agreed to take the survey in order for me to elicit opinions and feedback from persons other than myself and my thesis supervisor and who were also representative of the intended research participants and cooperating teachers. Three of the students were from the Environmental Club that I sponsored, one of the students was from my Japanese 12 class and the teacher was one of the authors of the *BC Science 10* textbook. The student and teacher survey writers were invited to provide comments or questions and voice any concerns to ensure clarity of the questions and to expose any errors. For example, one student asked if there could be more than one main language spoken at home so I made a change in the survey to reflect this inquiry. Another student asked whether I needed to include a third option

for the gender question. The teacher told me that most students learn the term carbon footprint, not ecological footprint, so I placed ecological footprint in parentheses. Unfortunately I found out much later that this information was incorrect. Further, in spite of multiple reviews, and a substantial amount of time spent on editing the survey, two questions numbered 14 were unintentionally created and went unnoticed resulting in 40, not 39, questions. This error was not discovered until a few months after the surveys were completed when the results were being entered into an Excel spreadsheet. For future reference, I will refer to these questions as 14a and 14b.

Administration of the Survey

Once I secured the agreement of six teachers from five secondary schools to oversee the recruitment of students; distribute and collect the invitation letters (see Appendix C) and student consent forms (see Appendix D); and to administer the paper surveys, I created packages for each teacher that contained the invitation letters, teacher consent forms (see Appendix E), student consent forms, copies of the surveys (see Appendix B), and detailed instructions (see Appendix F). At this point, I did not know how many students from each class would be willing to participate and submit their consent forms so I supplied the teachers with full class sets. I personally delivered each package to all the schools, which gave me further insight to the unique characteristics of each school. For example, I was not aware prior to the study that two of the schools had French immersion programs and that one of the schools had a composting program that was initiated by one of the school custodians.

I requested that the teachers try to complete everything within a 2-week period because I was expecting the birth of my first child the following month. All the teachers completed

everything in a timely manner and, in the end, out of potentially 150 students, 93 completed the survey—a return rate greater than 60%. All of the surveys were completed satisfactorily with only a few students leaving some items unanswered. I had planned to collect all the surveys from each school in order to personally thank each teacher, but this plan quickly changed when I gave birth to my daughter one month early. Alternatively, I asked teachers to courier the consent forms and completed surveys to my school in a secure envelope in order to have to make only one trip for pick up.⁴

Analysis of the Survey Data

Once I had all the completed surveys in my possession, I had the onerous task of entering student responses into an Excel spreadsheet (see Appendix G). I went through each survey individually and meticulously read out each response to my husband who recorded the answers on to graph paper and then reread them for accuracy. I then took the recorded answers and entered them into Excel. Once this time-consuming step was complete, I could then look at the results in an organized manner and view the Excel file to see how the students responded. Items 11 and 12, which inquired about outdoor activity experience and interest, provided several potential responses that would have been impossible to record into Excel; therefore, I had to manually record the answers after viewing each completed survey. The only way to have avoided this time-consuming task was to have designed the items differently.

By using the Excel spreadsheet to organize the response data, each survey item can be viewed separately, with the exception of Items 11, 12, and 32. Descriptive statistics—including

⁴ At the time of recruitment, I did not offer any type of incentive to the teachers for their participation, but once I had confirmation that they all couried the surveys to my school, I sent them a thank you card along with a \$15-dollar coffee card as a gesture of gratitude.

details such as gender, main language(s) spoken at home, the length of time as a secondary student in Surrey, or any courses with an environmental focus that they had studied—can also be analyzed with ease. Questions 13 to 17, 38, and 39 measured opinions or responses about opinions; therefore, a Likert-type scale was utilized for these questions (Leedy & Ormrod, 2013, p. 192). This survey was really designed to assess opinion, self-reported behaviour, and knowledge (information recall and application of learning) rather than being an attitudinal assessment. For the knowledge-based questions numbered 19 to 37, each multiple-choice item had only one corresponding correct answer. Gender differences were compared using Excel to determine if a difference existed between female and male student responses.

The structure of the survey allowed the participants to skip an item or not respond if they wished. Nevertheless, very few students left items unanswered. Thirteen of the 40 survey items had a maximum of one or two students who did not select a response (see Appendix G). Only actual responses were included in the calculation of percentages.

Obstacles and Solutions

I encountered the first obstacle in the research process while completing my thesis proposal. I realized that creating an online survey would require participating teachers not only to be responsible for recruiting students and to deal with the related paperwork but also to have access to a computer lab and make arrangements for their students to take the survey online. This step would create additional time constraints for the teachers. I did not want the format of the survey to deter teachers from wanting to participate. The added risk was that students might have difficulties logging in to the survey site or that they would access the Internet to look up answers.

A second challenge was that I was getting short on time and uncomfortably close to my baby's May 2 due date. I initially planned to have the surveys distributed before spring break in mid-March 2014, but I was two weeks behind schedule. I did not receive ethics approval from Royal Roads University until the first week of spring break and the subsequent SD 36 approval a few days later. Only half of the schools were open over the two-week spring break for me to deliver the survey packages, but I saw to it that the remaining packages were delivered in person once the schools reopened to avoid any delays. This quick action on my part turned out to be very fortunate as I went into labour one month early, one day after I completed delivering all the packages.

The third and last problem was related to the data entry of the survey responses. Because the surveys were in paper format, the process of manually entering the responses, accompanied by the potential for human error, was extremely time-consuming. Also, when developing the survey items, I overlooked the fact that all items could be entered into an Excel spreadsheet except Items 11, 12, and 32. These three items all had a multiple response format that was not compatible for processing with Excel. As a result I manually compiled the responses for Items 11 and 12. I discovered that Item 32, which asked students about the recognition of BC species, was poorly designed in that up to five correct responses were making it challenging to record the results conveniently and meaningfully. Therefore, I decided to exclude this item from the analysis.

Closing Thoughts

This chapter provided an overview of the chosen methods and methodology, the subsequent obstacles that were encountered, and the corresponding solutions that I chose to

make. The following chapter will present the results of the survey data using descriptive, rather than inferential, statistics.

Chapter Four: Results

This chapter presents the results of the research and summarizes the collected data. The structure of the chapter directly relates to the ordering of the 40 items of the ecoliteracy survey. The chapter begins with the results of a set of demographic questions, followed by a summary of responses to the behaviour and opinion items. The results of the environmental and ecological knowledge-based questions are presented next, followed by results for the two final opinion-based items. Figures in the form of charts are utilized selectively where necessary and tables containing the survey items are included to help represent the findings and to assist the reader. Table 3, which shows survey Items 1 to 8, is the first of the tables. I have also included response choices for each item and, where possible, the results in raw numbers for each item.

Demographic Information

Ninety-three Grade 12 students completed the survey of which 52% were female and 48% were male. Two students did not indicate their gender. It is conceivable that they simply overlooked the question or that they did not identify specifically with either gender. The number of students who indicated that English was the main language spoken at home was 48 (52%) whereas 30 (32%) spoke English and at least one other language at home. Fifteen (16%) students indicated that they spoke a language or languages other than English at home. This appears to be consistent with the ethnic diversity of the City of Surrey as described in Chapter 3.

As shown in Table 3, the majority of the students who completed the survey had attended the same Surrey secondary schools from Grades 8–12. The remainder had studied at several different schools in the Surrey district whereas others had attended other BC schools or schools

in other provinces or outside Canada. The results suggest that most of the survey respondents would have experienced generally similar secondary school programs, including Science.

Table 3

Survey Items 1 to 8 with Response Choices and Results in Raw Score Numbers

1. What is your gender? M **44** F **47** blank **2**
2. What is the **main language(s)** spoken by you and your family at home? (See the next page text for results.)

o English	o Punjabi	o Spanish
o Chinese	o Hindi	o French
o Tagalog	o Arabic	o Other_____
o Vietnamese	o Lao	
3. Which of the following statements best describes your educational history?

a. I have spent grades 8 to 12 at the same secondary school in Surrey.	69
b. I have spent grades 8 to 12 at more than one Surrey secondary school.	4
c. I have spent grades 8 to 12 both in Surrey and at other BC secondary schools.	8
d. I have spent at least two years studying in another province.	2
e. I have spent at least two years studying outside of Canada.	9
4. Did you or do you belong to an environmental club at your secondary school? **Yes 10 No 83**
5. Did you or do you belong to any clubs or organizations outside of school that have an environmental focus (i.e., Scouts, Girl Guides, Outward Bound)? **Yes 12 No 80 blank 1**
If yes, which one(s)? _____
6. Did you take Science 10 in BC? **Yes 88 No 5 blank 1**
7. Have you studied or are you currently studying Biology 11? **Yes 46 No 47**
8. Have you studied or are you currently studying a secondary course with an environmental education focus (i.e., Sustainability, Environmental Leadership)? **Yes 3 No 90**
If yes, which one(s)? _____

Table 3 also shows that few students had environmental club experience at their secondary school and even fewer belonged to a club or organization outside of school that had an environmental focus. Only two of the students who belonged to an environmental club indicated that they also had belonged to an outside club or organization. The non-school organizations that were cited by students for Item 5 were Brownies, Girl Guides, the City of Surrey, the Vancouver Aquarium, and Surrey Stewardship. One student had been affiliated with three organizations:

Green Recycling Inc., Lower Mainland Green Team, and Surrey Youth Stewardship Squad. One student specified “sports” when responding to Item 4.

The majority of students (97%) indicated that they had studied Science 10 in BC with only three responding that they had not studied science in BC. This result is notable since most of the knowledge-based survey items were designed under the assumption that the participants would have studied BC Science 10 in high school. When asked if they studied Biology 11, a science elective course, the results showed almost an even distribution among students who had studied Biology 11 and those who had not. Of the three students who indicated that they had studied a secondary school course with an environmental focus, one respondent indicated Geography 12 as the course.

Experiences with Outdoor Environmental Activities

Survey Items 9 through 12 asked students about time spent outdoors and their involvement in outdoor activities. Table 4 presents these survey items in the order that participants would have viewed and responded to them and the results for Items 9 and 10.

Table 4

Survey Items 9 to 12 with Response Choices and Results in Raw Score Numbers

- | | | |
|----|--|-----------|
| 9. | How often do you spend time in the outdoors/a natural setting (i.e., park, forest, lake, river or ocean) | |
| | a. never or almost never | 4 |
| | b. a few times a year | 19 |
| | c. at least once a month | 23 |
| | d. about once a week | 23 |
| | e. more than once a week | 24 |

10. How often have you participated in **field trips organized by your secondary school** that take place in the outdoors/ in a natural setting?
- a. never **20**
 - b. once or twice **45**
 - c. more than twice **20**
 - d. at least once a year **7**
11. Which of the following outdoor activities **have you tried in the past?** (circle all that apply)
- a. hiking, trail running, nature walks
 - b. tent camping
 - c. RV camping
 - d. kayaking, canoeing
 - e. rock climbing, mountaineering
 - f. snowshoeing, cross country skiing, back country skiing, outdoor ice skating
 - g. downhill skiing, snowboarding
 - h. cycling, mountain biking
 - i. surfing, windsurfing, wake boarding
 - j. hunting, fishing
 - k. swimming in ocean, lake, river
 - l. orienteering
 - m. nature photography/art work in the outdoors
12. Which of the following outdoor activities would you **want to try?** (feel free to rank with a number)
- a. __hiking, trail running, nature walks
 - b. __tent camping
 - c. __RV camping
 - d. __kayaking, canoeing
 - e. __rock climbing, mountaineering
 - f. __snowshoeing, cross country skiing, back country skiing, outdoor ice skating
 - g. __downhill skiing, snowboarding
 - h. __cycling, mountain biking
 - i. __surfing, windsurfing, wake boarding
 - j. __hunting, fishing
 - k. __swimming in ocean, lake, river
 - l. __orienteering
 - m. __nature photography/art work in the outdoors
 - n. __none
-

As shown in Table 4, student responses in regard to the amount of time spent outdoors or in natural settings revealed a general distribution across a range from regular, weekly activities to only a few times each year. These results suggest that the students who completed the survey

were by no means all extremely active in outdoor pursuits, nor were they all inactive or uninvolved in such activities.

Items 11 and 12 related to the students' past experiences and potential interests in outdoor activities and to whether they had actually tried such activities or would have liked to try them. Students were offered a choice of several possible responses. As a result, the data for these questions were manually calculated and tallied. Figures 2 and 3 show the results for survey Items 11 and 12 displaying the greatest to least popular choices.

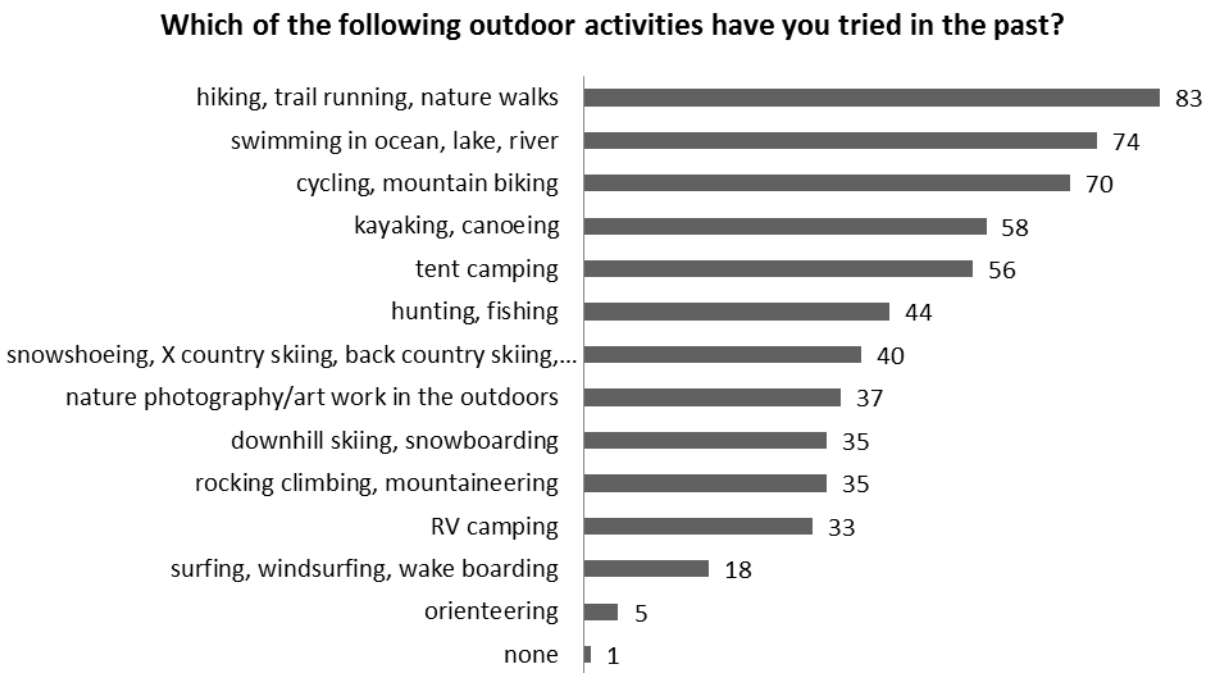


Figure 2. Responses to survey Item 11: “Which of the following outdoor activities have you tried in the past? (Circle all that apply).” Numerical values shown for number of participants.

The purpose of Item 11 was to determine what outdoor activities the surveyed Grade 12 students had personally experienced. The results indicate that among the choices, “hiking, trail running, nature walks” were the most common responses, followed by “swimming in ocean, lake, river” and “cycling, mountain biking.” Very few students indicated that they had tried

orienteering, although the results for Item 12 show that over one quarter were interested in trying this activity. One weakness of Item 11 is that it did not take into consideration how many times a student had tried the activity or if they participated in it regularly.



Figure 3. Results in responses to survey Item 12: “Which of the following outdoor activities would you **want to try**? (feel free to rank with a number).”

The purpose of Item 12 was to determine the Grade 12 students’ intentions for outdoor activities. The list of activities for this survey item was the same as Item 11. Among the choices, “surfing, windsurfing, wakeboarding” were indicated as the most popular intentions or future preferences, followed by “downhill skiing, snowboarding.” These results are not surprising as Surrey is located relatively close to the ocean and ski hills. The least popular response was “swimming in ocean, lake, river,” which was unexpected considering the students’ most popular choices involved activities that all take place in water.

Surprisingly the top three activities that many students had tried in the past were listed as the least popular activities they would want to try. It is difficult to ascertain if they did not enjoy

these activities or if they simply wanted to try outdoor activities that were new to them. A weakness of this question is that it included “feel free to rank with a number” in the instructions. Although few students ranked their preferences, it would have been challenging to manually enter and analyze such results.

Student Environmental Behaviours and Opinions on Environmental Issues

Survey Items 13 and 14a asked students about their school’s environmental culture. As previously mentioned, the first Number 14 of the survey is referred to as 14a. Table 5 presents these survey items in the order that participants would have viewed and responded to them.

Table 5

Survey Items 13 and 14a with Response Choices and Results in Raw Score Numbers

13. The overall culture of my secondary school promotes behaviours and attitudes that support green practices such as recycling, waste/garbage reduction, and energy conservation.	
a. I strongly agree with this statement.	47
b. I somewhat agree with this statement.	40
c. I somewhat disagree with this statement.	5
d. I disagree with this statement.	1
14a. The overall school culture of my secondary school classes promotes behaviours and attitudes that support an appreciation for nature and non-human species.	
a. I strongly agree with this statement.	13
b. I somewhat agree with this statement.	57
c. I somewhat disagree with this statement.	17
d. I disagree with this statement.	6

As can be seen in the responses in Table 5, the majority of students generally agreed that their school culture promoted behaviors and attitudes that supported green practices.

Nevertheless, there was greater division of opinion in regard to whether the school culture promoted an appreciation for nature and non-human species with approximately one quarter of the students disagreeing that this was the case. It should be noted that the students may not have

understood what was meant by an appreciation for nature and non-human species and the item could have been improved by including examples.

Survey Items 15 to 18 comprised a series of statements and questions that asked students to respond concerning their behaviours and opinions in regard to selected environmental topics. Table 6 presents the results for the survey items in the order that participants would have viewed and responded to them.

Table 6

Survey Items 15 to 18 with Response Choices and Results in Raw Score Numbers

15. How often do you think about where your garbage ends up?
- | | |
|-------------------|-----------|
| a. frequently | 23 |
| b. sometimes | 23 |
| c. not very often | 37 |
| d. never | 10 |
- 14b. Which of the following statements **best** describes your behaviour?
- | | |
|--|-----------|
| a. I make an effort to recycle and reduce my waste both at home and at school. | 13 |
| b. I make an effort to recycle and reduce my waste at home but not at school. | 57 |
| c. I make an effort to recycle and reduce my waste at school but not at home. | 17 |
| d. I rarely/never make an effort to recycle or reduce my waste at home or at school. | 6 |
16. How concerned are you about climate change?
- | | |
|-------------------------|-----------|
| a. very concerned | 23 |
| b. somewhat concerned | 40 |
| c. not very concerned | 26 |
| d. not concerned at all | 4 |
17. In 2007, the BC government created targets to reduce greenhouse gas emissions by 2020 by at least 33% lower than the 2007 levels. How likely do think these targets will be met?
- | | |
|----------------------|-----------|
| a. very likely | 1 |
| b. somewhat likely | 44 |
| c. not very likely | 40 |
| d. not likely at all | 8 |

18. Which of the following statements represents your personal views?
- a. Growing the economy and job creation is more important than protecting the environment. **7**
 - b. Protecting the environment is more important than growing the economy and job creation. **13**
 - c. There should be a balance between growing the economy/job creation and protecting the environment. **72**
-

Approximately half of the students responded that they did not think about where their garbage ended up. The results for recycling and waste reduction show that students were more likely to recycle and reduce their waste at home than at school. Figures 4 and 5 show the response data for survey Items 16 and 17, which were directed at student opinions about the issue of climate change and the reduction of greenhouse gases in BC.

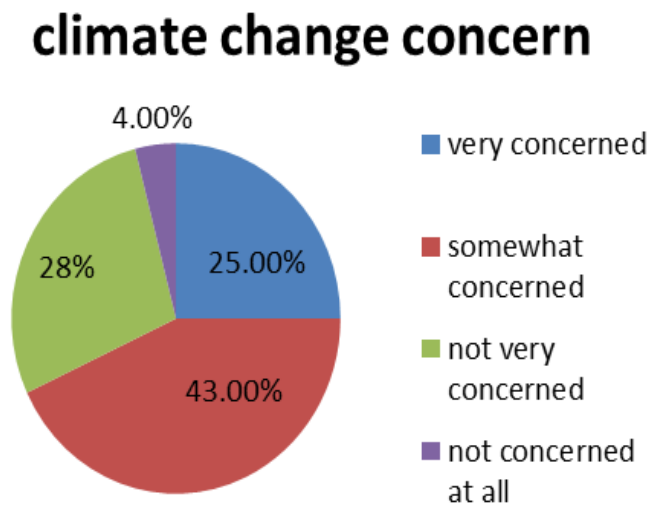


Figure 4. Results in response to Item 16, "How concerned are you about climate change?"

In 2007, the BC government created targets to reduce greenhouse gas emissions by 2020 by at least 33% lower than the 2007 levels. How likely do you think these targets will be met?

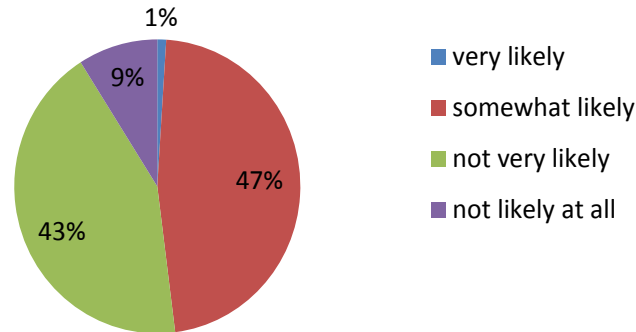


Figure 5. Results in response to Item 17: “In 2007, the BC government created targets to reduce greenhouse gas emissions by 2020 by at least 33% lower than the 2007 levels. How likely do you think these targets will be met?”

The results shown in Figures 4 and 5 indicate considerable student concern about the overall issue of climate change while students were divided over whether they believed that the BC government would meet its greenhouse gas emissions targets. It is perhaps encouraging that a considerable number of these young adults appear not to have been highly doubtful or cynical about potential political actions to achieve reductions in greenhouse gases. Nevertheless, more than half were uncertain that the government would meet their greenhouse gas emission targets by 2020.

Item 18 was the final question before the knowledge-based item section. Not surprisingly, more than three-quarters of students responded that a balance should exist between growing the economy/job creation and protecting the environment. It is possible that these results reflected the actual opinions of these students, but it is also likely they may have been influenced by what they see and hear in the media regarding BC’s expanding green economy.

Knowledge Items

Survey Items 19 to 23 were knowledge-based questions related to the atmosphere and greenhouse gases. Table 7 presents these survey items in the order that participants would have viewed and responded to them.

Table 7

Survey Items 19 to 23 with Response Choices and Results in Raw Score Numbers

- | | |
|---|-----------|
| 19. What is the most abundant gas in our atmosphere? | |
| a. carbon dioxide | 50 |
| b. oxygen | 17 |
| c. nitrogen | 25 |
| d. argon | 1 |
| 20. Which of the following is not a greenhouse gas (GHG)? | |
| a. carbon dioxide | 4 |
| b. nitrogen | 7 |
| c. water vapour | 72 |
| d. methane | 10 |
| 21. Which gas is known to be emitted from the decomposition of material in landfills and from organic wastes from livestock (i.e., cattle, pigs)? | |
| a. nitrogen | 15 |
| b. methane | 54 |
| c. chlorofluorocarbons | 21 |
| d. ozone | 3 |
| 22. Which country contributes the greatest amount of greenhouse gases per person ? | |
| a. Canada | 9 |
| b. China | 41 |
| c. Germany | 0 |
| d. India | 4 |
| e. United States | 37 |
| 23. The current approximate global average proportion of CO ₂ in our atmosphere measures in the range of _____ parts per million. | |
| a. 250-300 | 3 |
| b. 380-400 | 17 |
| c. 570-610 | 7 |
| d. I do not know. | 66 |

The intent of Items 19 to 23 was to assess student understanding of the composition of the atmosphere and the knowledge of the nature and relative abundance of greenhouse gases, in

particular carbon dioxide. The first of the knowledge-based questions in this group asked students a basic question about the composition of the atmosphere: “What is the most abundant gas in the atmosphere?” In this group of Grade 12 students, the majority thought that carbon dioxide was the most abundant gas in the atmosphere when in fact nitrogen is the most abundant constituting. It is possible that because students read and hear a lot about the importance of carbon dioxide as a greenhouse gas related to climate change, that they may have assumed that it must also be abundant when in fact it is less than 1% of the atmosphere. In total, 73% of the students responded incorrectly to Item 19.

Item 20 offered students a list of atmospheric gases and asked them to identify which one was **not** a greenhouse gas—possibly a tricky question. Ninety-two percent of students answered this item incorrectly. The majority of the students selected water vapour as *not* being a greenhouse gas—a reasonable but incorrect assumption. Perhaps the students’ thinking was that something as common and harmless as water vapour could not be a greenhouse gas. Here again, the student responses also suggest a lack of understanding of the greenhouse effect and a poor understanding of the importance and roles of nitrogen in the atmosphere. While nitrogen is the most abundant element of the atmosphere (78%), it is not a greenhouse gas. It was interesting to discover that almost 10 percent of the students felt that methane was not a greenhouse gas when in fact it is an important contributor to the so-called greenhouse effect. It is strange, however, that for Item 21, which asked about gases generated from the decomposition of organic material, the majority of the students correctly selected methane, even though its importance as a greenhouse contributor was not recognized.

Figure 6 shows how the students' ranked the list of country's contributions of greenhouse gases compared to the actual ranking of the same countries according to current studies (Weaver, 2011). As is shown, although, as a nation, China contributes the greatest total greenhouse gases, the United States creates the most greenhouse gases on a per capita basis (Weaver, 2011). Item 22 included Germany as a choice option, but since no students selected it, it has not been included in Figure 6. While fifty-eight percent of students answered this question incorrectly, the significance of the student responses to this item is somewhat difficult to assess since the actual rankings are based on per capita measures. Students may have responded to this question thinking it directly related to population size and chose the most populous country, China, which is probably a common error for many people. Figure 7 shows the actual carbon dioxide emissions per capita for the five countries that were response options for Item 22.

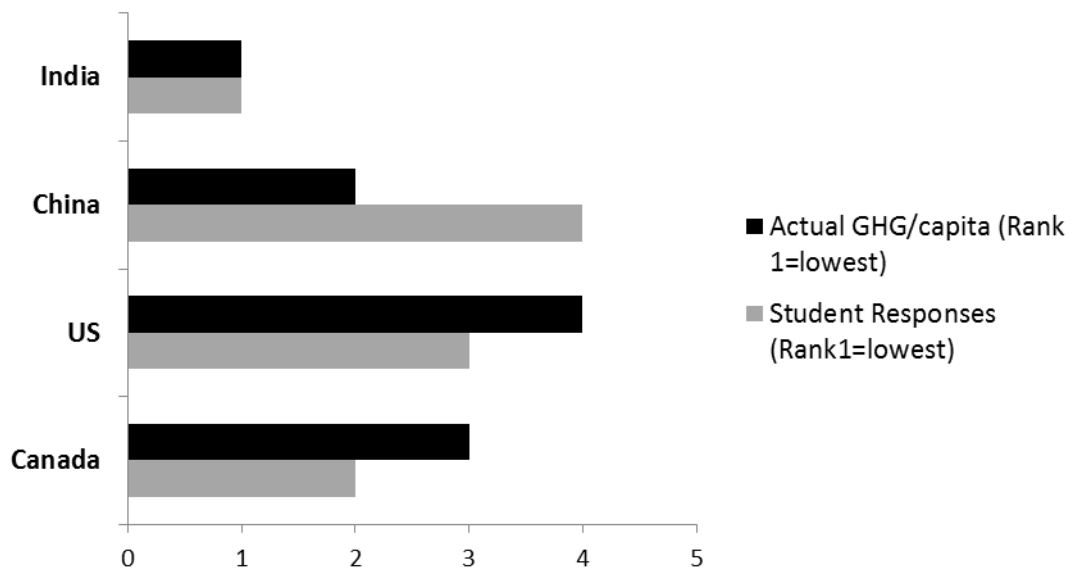


Figure 6. Results in responses to Item 22: “Which country contributes the greatest amount of greenhouse gases **per person**?” Comparison between student ranking of country contributions to actual known ranking (Weaver, 2011).

**Carbon Dioxide Emissions Per Capita
Measured in Metric Tonnes of Carbon
(2010)**

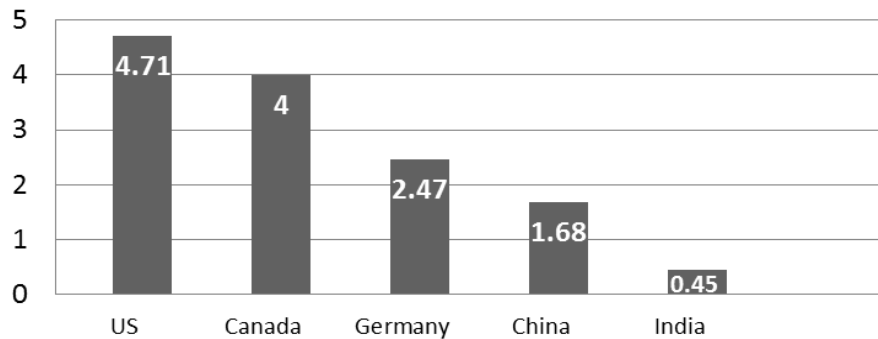


Figure 7. This figure shows the actual carbon dioxide emissions per capita for the five countries that were response options for Item 22: “Which country contributes the greatest amount of greenhouse gases **per person?**”

Note. Adapted from Boden, T. A., G. Marland, and R. J. Andres. 2013. *Global, Regional, and National Fossil-Fuel CO₂ Emissions*. Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy, Oak Ridge, TN. doi:10.3334/CDIAC/00001_V2013. Retrieved from <http://cdiac.ornl.gov/trends/emis/top2010.cap>

Item 23 asked about the current approximate global average of carbon dioxide in the atmosphere. The correct answer was 380–400 ppm (parts per million). As is shown in the data, a majority of students selected the “I do not know” response and less than 20% answered correctly. For these particular students, the problem here may relate to the measurement (parts per million) as being an unfamiliar way of describing the composition of gases in a mixture. It is also possible that the students were not familiar with the statistic. Further, although there is a reference to Canada’s projected industrial greenhouse gas emissions in Chapter 4 of *BC Science 10* (Sandner et al., 2008) textbook, the measurement used is millions of tonnes instead of parts per million.

Survey Items 24 to 30 were knowledge-based questions related to the status of knowledge about human contributions to climate change (greenhouse gases and the use of fossil fuels).

Table 8 presents these survey items in the order that participants would have viewed and responded to them.

Table 8

Survey Items 24 to 27 with Response Choices and Results in Raw Score Numbers

24. Which of the following statements **best reflects** the current state of scientific opinion as summarized by the IPCC (Intergovernmental Panel on Climate Change)?
- | | |
|---|-----------|
| a. The majority of scientists believe that the current rate of climate change is real and caused by human activity. | 58 |
| b. Some scientists believe that the current rate of climate change is real and caused by human activity. | 31 |
| c. Scientists do not agree on what is causing climate change. | 2 |
| d. Most scientists do not believe that the current rate of climate change is caused by human activity. | 2 |
| e. Scientists do not believe there has been a significant change in the rate of climate change. | 0 |
25. Which of the following observed changes are believed to be effects of global climate change?
- | | |
|--|-----------|
| a. acidification of the oceans | 11 |
| b. animals breeding earlier than normal | 1 |
| c. an increase in the number and size of jellyfish | 0 |
| d. some coral reefs are dying off | 6 |
| e. all of the above | 56 |
| f. a and b only | 10 |
| g. none of the above | 9 |
26. Which of the following events **best** describes one of the outcomes of climate change?
- | | |
|--------------------------------------|-----------|
| a. a decrease in drought | 1 |
| b. an increase in tsunamis | 9 |
| c. an increase in average sea levels | 65 |
| d. a decrease in ozone depletion | 17 |
27. The carbon footprint (also known as ecological footprint) of someone in Vietnam is approximately **.76**. What is the approximate carbon footprint for someone living in Canada?
- | | |
|--|-----------|
| a. 1.8 | 20 |
| b. 3.9 | 18 |
| c. 5.7 | 19 |
| d. 8.5 | 8 |
| e. I do not know what a carbon footprint is. | 28 |

For Item 24, “Which of the following statements best reflects the current state of scientific opinion as summarized by the IPCC (Intergovernmental Panel on Climate Change)?”, many of

the students accepted the statement that the majority of scientists believe that the current rate of climate change is real and is caused by human activity. Nevertheless, other students indicated that there was less consensus among scientists, while other students apparently believed either that scientists do not agree on the causes of climate change or that scientists do not believe climate change is caused by human activity. While 62% of students did elect the response choice that best reflects the current scientific consensus, the overall pattern of responses may suggest a need for more effective discussion in science classes regarding this topic.

The content of Items 25 and 26 focused on identifying outcomes of climate change. For Item 25—“Which of the following observed changes are believed to be effects of global climate change?”—many students were able to recognize that all of the listed observed changes (response choices a to d) were believed to be effects of climate change. Nevertheless, it is notable that almost 10 percent of the students elected “none of the above” as their choices. This result indicates that there is a need for better description of climate change effects in general, rather than an emphasis only on atmospheric effects, in the current science curriculum.

Item 26, probed further for student knowledge of the effects of climate change, extending the focus of Item 25 by taking a slightly different approach by asking about which of several possibilities best described one of the outcomes of climate change. The majority of students selected “an increase in average sea levels” as the correct answer. Eighteen percent of the respondents chose a “decrease in ozone depletion” as their response. This may reveal some level of confusion among students about the relationship between ozone depletion and climate change.

Only a small number of students responded correctly to Item 27, “The carbon footprint (also known as ecological footprint) of someone in Vietnam is approximately .76,” and which

also asked “What is the approximate carbon footprint for someone living in Canada?” The pattern of responses here would seem to indicate that many students do not understand the terms “ecological” or “carbon” footprint and that they have either not been introduced to the concepts or have not retained the ideas into Grade 12. Unfortunately, these results are somewhat difficult to assess accurately since the term carbon footprint was used in error.

Survey Items 28 to 30 were knowledge-based questions related to knowledge and opinion related to environmental issues with an emphasis on British Columbia and local issues. Table 9 presents these survey items in the order that participants would have viewed and responded to them.

Table 9

Survey Items 28 to 30 with Response Choices and Results in Raw Score Numbers

28. What is the approximate size of the Great Pacific garbage patch in the Pacific Ocean?	
a. I have never heard of the Great Pacific garbage patch.	34
b. 10 football fields	28
c. Vancouver Island	12
d. larger than Texas	18
29. What is the main source of electrical energy for BC homes?	
a. coal burning power plants	11
b. solar energy collectors	5
c. hydroelectric dams	71
d. wind turbines/windmills	6
30. What plastics are not accepted into the City of Surrey’s residential recycling program?	
a. 1, 2, 3, 6	7
b. 2, 3, 4	6
c. 3, 6, 7	16
d. All plastics #1-7 are accepted.	13
e. I do not know.	51

Student responses to Item 28 concerning the size of the Great Pacific garbage patch revealed either confusion or lack of awareness even about the nature of the phenomenon. Part of

the problem here may relate to the focus of the item on the size of the garbage patch, rather than on determining whether or what the students knew about the issue at all.

For Item 29, over three-quarters of participants knew that hydroelectric dams are the main source of electrical energy for BC homes. This result suggests that there was general knowledge among the students about how BC generates the majority of its electric power and may reflect years of news releases and other media reports around the construction of new hydroelectric dams. Even the name of BC's major electrical utility, BC Hydro, suggests and reinforces hydroelectricity's importance to BC.

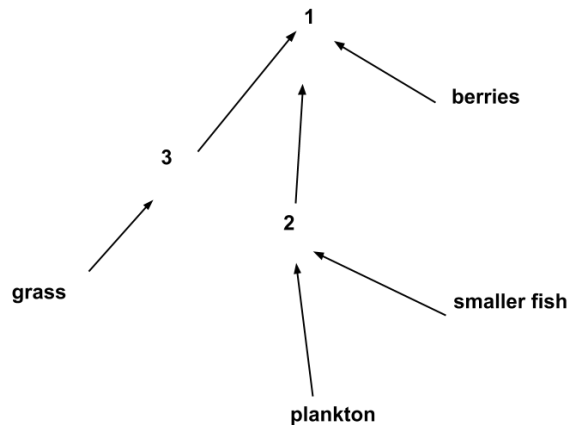
Item 30 directly assessed the students' knowledge about recycling policies and practices in the City of Surrey. The item focused on specific knowledge about which types of plastic materials were **not** accepted into City recycling programs in Surrey. Since fifty-five percent of the students indicated that they did not know this information, it would seem that there is much to be done by way of effective public education around this matter and that school programs should foster better understanding among students who in turn can educate their families.

Survey Items 31 to 37 covered topics related to species identification and BC natural history, threats to species populations, and a basic understanding of ecosystems. Table 10 presents these survey items in the order that participants would have viewed and responded to them. Item 32, which asked students to identify animals that live in BC, was poorly designed and, therefore, was excluded from the results.

Table 10

Survey Items 31 to 37 with Response Choices and Results in Raw Score Numbers

31. What is BC's provincial flower?
- a. crocus **5**
 - b. daffodil **9**
 - c. dogwood **58**
 - d. tulip **11**
 - e. wild rose **8**
32. Which of the following animals live in BC? (circle all that apply)
- a. salamander
 - b. river otter
 - c. Bald eagle
 - d. manatee
 - e. Kermode (Spirit) bear
 - f. Marmot
33. The Mountain Pine Beetle has caused extensive damage to the forests of the north and interior of BC. Which of the following is a **major factor** in this event?
- a. The population of the beetles' predators has decreased. **20**
 - b. The winter temperatures are no longer cold enough to kill the adults, eggs and larvae. **34**
 - c. The beetles have adapted so that they can resist the defence provided by tree resin. **26**
 - d. The new trees cannot grow large enough to defend themselves. **12**
34. What is the main reason that pandas in China have become an endangered species?
- a. Poachers are killing them for their fur and paws. **26**
 - b. They are being sold illegally as exotic pets and for zoos. **6**
 - c. The deforestation of bamboo forests makes their food supply scarce. **55**
 - d. They are not an endangered species. **4**
35. What North American population has been significantly reduced and threatened due to illegal logging activity and a decrease in its food supply caused by the use of herbicides?
- a. black bear **32**
 - b. beaver **36**
 - c. Monarch butterfly **14**
 - d. bison **10**



36. The above diagram represents a food web. Which of the following species should be placed in the **position #1** on the Food Web diagram?
- a. salmon **3**
 - b. elk **7**
 - c. grizzly bear **76**
 - d. algae **5**
37. Which of the following species should be placed in the **position #2** on the Food Web diagram?
- a. salmon **74**
 - b. elk **7**
 - c. grizzly bear **4**
 - d. algae **7**
-

In general, student responses to Items 31 and 33 suggest that the participants had some basic knowledge about BC natural history. This is a survey area that could have been increased in number of questions. Some biologists and natural historians have expressed concerns that modern students recognize more corporate logos than local species of plants, birds, and mammals. Nevertheless, sixty three percent of the students were able to correctly identify the dogwood as BC's provincial flower and when asked about the major factor in the Mountain Pine Beetle epidemic, over one third of the students recognized that the warmer winter temperature was the correct answer. These questions hardly constitute an extensive probe into the students' local wildlife knowledge and appreciation. It was also unfortunate that Item 32 was poorly designed making the data difficult to tally and analyse.

Items 34 and 35 addressed understandings related to threats to species and species habitat. The responses revealed some confusion around specifics. For examples, while the majority of the students knew that pandas in China have become an endangered species due to the deforestation of the bamboo forests, a considerable number chose poaching as the cause of endangerment for the panda. Loss of habitat is a more subtle threat than the obvious and aggressive effects of poaching. There still seems to be a need for educational programs to clearly describe the full

range of threats to species and emphasize the importance and the nature of habitat loss, especially in our own local environments in BC. Item 35 assessed student knowledge of species in North America that are threatened. More students selected the black bear and the beaver rather than the Monarch butterfly. However, the Monarch butterfly is better known in Central Canada than in BC. These students may have much more awareness of common species like the black bear and the beaver than of the Monarch butterfly and may not understand the ecological importance of this butterfly species.

The last two knowledge-based survey items required students to view a basic food web diagram and determine the placement of member species on the web. The majority of students were able to successfully locate the grizzly bear at the top of the food web and were able also to place the salmon in its correct position. This reveals that there was a basic level of conceptual knowledge related to ecological relationships and food webs among these students.

EE in the School Curriculum

The last two items of the survey asked whether the students felt that their high school education had adequately equipped them to understand basic ecological knowledge and environmental problems as well as how important they thought it was to learn about ecosystems and environmental topics. Table 11 presents these survey items in the order that participants would have viewed and responded to them.

Table 11

Survey Items 38 and 39 with Response Choices and Results in Raw Score Numbers

38. How well do you feel your high school education has equipped you to understand basic ecological knowledge and environmental problems?	
a. very adequately	8
b. somewhat adequately	50
c. not very adequately	25
d. not adequately at all	10
39. How important do you think it is to learn about ecosystems and environmental topics?	
a. very important	46
b. somewhat important	40
c. not very important	6
d. not important at all	1

In contrast to Item 38, in which 62% of students expressed the view that they had not been adequately prepared to understand basic ecological concepts and environmental issues, the responses to Item 39 show that most of the students agreed that learning about ecosystems and environmental topics is important, with a majority of those who agreed thinking it was very important. Only one student indicated it was not at all important. Figure 8 shows the results for the final survey item.

How important do you think it is to learn about ecosystems and environmental topics?

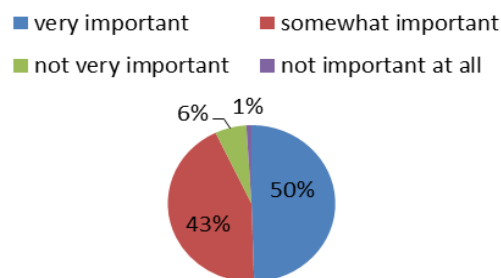


Figure 8. Responses to Survey Question 39: “How important do you think it is to learn about ecosystems and environmental topics?”

Overall, the responses for Item 39 are very encouraging. The results show that the majority of students agreed that learning about ecosystems and environmental topics is important, with the majority of those students thinking it was very important.

By the end of the survey, the response data show that the majority of participants had read and responded to all of the behaviour, attitude, and knowledge-based items, as nonresponse rates were low. The students might have responded differently had the questions appeared at the beginning of the survey. The designed ordering of the survey items might have given the respondents a sense of their own ecological and environmental literacy, allowing them to respond to questions 38 and 39 more accurately and honestly.

The survey that generated the responses and results shown in this chapter was a preliminary inquiry into a group of BC Grade 12 students regarding environment-related activities and issues and their general knowledge of some important environmental and ecological concepts. The implications of the findings and further recommendations will be discussed in detail in Chapter 5.

Chapter 5: Research Findings and Interpretation of the Results

The purpose of this research was to explore whether Grade 12 students in BC were graduating with behaviours, attitudes, and knowledge consistent with the construct of environmental literacy. The study also set out to determine what recommendations, if any, could be made to improve the BC curriculum so that graduates could develop the knowledge, skills, and attitudes associated with the constructs of environmental literacy, ecological literacy, and ecoliteracy. This chapter highlights the key research findings and interprets the survey results in order to address these two main research goals.

The research for this thesis is in the genre of a polling study in that it took a “snapshot” of a sample of BC Grade 12 students who volunteered to complete a survey. The survey included items that asked for students’ responses to a series of questions related to their experiences and lifestyles in the environment, knowledge of some basic environmental facts and concepts, and their opinions about some environmental issues. The sample of students who participated was relatively small and was drawn from high schools selected to be representative of the major demographic and socio-economic areas of a large and diverse school district. No attempt was made to select students based on their academic performances, course selections, or particular involvement in environmental activities. All the students were enrolled in Grade 12, the last year of secondary school. The survey sample was small in comparison to trend polling research conducted by major research organizations or government agencies. In this sense, the results are to be considered as preliminary and suggestive rather than definitive or broadly generalizable.

General Analysis of Demographic Survey Items

The results of the survey revealed that almost half (48%) of students spoke other languages aside from English, a finding that is consistent with the ethnic diversity of SD 36 as described in Chapter 2. Such diversity is generally representative of urban school populations in Metro Vancouver, but is not typical of most BC schools, especially those in the interior and northern BC where immigration occurs less. It would be difficult to conclude if the multiethnic nature of the population was a factor in how students responded to the survey items as the majority of the students indicated that they spent all of their secondary school years studying in Surrey district. What can be concluded is that all participants had been enrolled in the BC secondary school curriculum and that Science 10 was the course that had been taken by all students in this sample, with the exception of three individuals. SD 36 is not representative of all BC secondary schools; hence, I will not be making any generalizations about all BC Grade 12 students based on this research. Nevertheless, the findings from the responses to Items 19 to 27, 33, 34, 36, and 37, which were specifically grounded in topics related to the BC Science 10 curriculum, may be more representative as all students are exposed to the same basic course.

Time Spent Outdoors

Roughly half (51%) of the surveyed students responded that they spent time outdoors or in a natural setting either once a week or more often. This conclusion was somewhat encouraging because there has been concern that youth today do not spend enough time in the outdoors. On the other hand, it also means that almost half the surveyed students were spending little time outdoors. Furthermore, the results for Item 10, which asked students about field trips that had been organized by their schools in which they had participated and that took place in the outdoors

and/or natural settings, indicated that almost one quarter had never been on such a field trip. The interpretation of responses to questions about time spent outdoors is problematic in that some students may include time walking to and from school in that category or athletic activities in indoor facilities or sports fields. I did, however, consider the problem of interpretation when designing survey Item 9 and included the following examples in parentheses as part of the question: park, forest, lake, river or ocean.

Surrey secondary schools could possibly do a better job to increase these low participation rates by providing teachers and students with outdoor field trip opportunities. Some of the field trips that are organized by the secondary school where I have taught include an annual hike up the Black Tusk in Garibaldi Provincial Park for Geography 12, Geology 12, and Physical Education 11/12 students, and a canoe trip at Widgeon Creek for Social Studies 10 students. Physical Education students also visit nearby Tynehead Regional Park for trail runs, and this park has also been the setting for the Grade 8 class retreat. Approximately twice a year, I organized nature walks in the Tynehead Park for the Environmental Club students; however, these example trips only happen because certain teachers organize them. A majority of students are still denied these outdoor experiences if they do not study certain courses or belong to a club. The Black Tusk hike can only take 50 students maximum out of the combined Grades 11 and 12 population of approximately 550 students, and it would be surprising if more than 10 students from the Environmental Club showed up for the nature walk even though all students, not just club members, and staff are invited. As previously mentioned in Caner's (2009) research, many teachers do not want to organize outdoor field trips because they face obstacles in terms of completing required paperwork related to liability issues. They may also be hesitant to organize a

field trip that takes place in an unfamiliar setting, which may be perceived to be out of their comfort zone or skill set and as potentially risky compared to an indoor classroom.

Behaviour and Attitude Items

The majority of participants (94%) strongly agreed or somewhat agreed that their secondary schools were promoting behaviours and attitudes that supported green practices. Nevertheless, when asked to respond to the statement, “The overall school culture of my secondary school classes promotes behaviours and attitudes that support an appreciation for nature and nonhuman species,” the schools did not fare as well. Approximately one third did not agree with this statement. It is possible that the students did not understand the combination of “an appreciation for nature and non-human species.” The other word that may have been problematic is appreciation, as the word is quite subjective. Perhaps it would have been a better choice to design a survey item that asked the participants how important they thought it was to respect and preserve nature and nonhuman species, rather than ask them whether the culture of their respective schools promoted behaviours and attitudes that support appreciation for both nature and nonhuman species.

Goal 4 in the Science 8–10 curriculum (2008) stated, “Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society and the environment” (BC MoE, 2008, p. 12). This Integrated Resource Package cited “assess human impact” (BC MoE, 2008, p. 41) and “show respect and sensitivity for the environment” (p. 41) under the list of skills and attitudes for life science. Four of the prescribed learning outcomes (PLOs) for the Science 10

units entitled “Sustainability of Ecosystems” and “Earth and Space Science: Energy Transfer in Natural Systems” are as follows:

- B1. explain the interaction of abiotic and biotic factors within an ecosystem;
- B2. assess the potential impacts of bioaccumulation; and
- B3. explain various ways in which natural populations are altered or kept in equilibrium.
- D3. evaluate possible causes of climate change and its impact on natural systems. (BC MoE, 2008, p. 30)

These four PLOs are congruent with the development of ecological and environmental literacy as discussed in Chapter 2, but a fifth PLO could be easily added to incorporate the concept of appreciation of other species.

It is unrealistic to expect the Science 10 curriculum to deliver all the content required to develop environmental literacy. The results for these survey items suggest that the curricula for other secondary courses could be re-examined for their inclusion of topics related to non-human species appreciation and other nature-related topics. Nature appreciation or appreciation of non-human species could form part of a number of courses—not just Science—but English, Art, and possibly Social Studies. This approach would be similar to how the topic of social responsibility is currently discussed in variety of secondary classes. I have personally been able to incorporate similar environmental topics in both my Visual Arts and Japanese classes.

Roughly half of the participants indicated that they did think about where their garbage was disposed and over two-thirds claimed that they made an effort to recycle and reduce their waste at home and at school. A problem existed, however, with the survey item that inquired about these behaviours; the term effort was used in the question and can be interpreted differently

by different people. A student could make an effort to recycle a pop can or juice container, but if that student is unable to find a recycle bin nearby, the container may end up in the garbage bin. An occurrence that happened with my most avid Environmental Club member, who often acted as the leader for the club's initiatives and who also participated as one of my survey pilot writers, illustrates this issue of item interpretation. When taking the pilot survey, this student indicated that she did make an effort at school and at home to reduce her waste. Every year for our bake sale fundraiser, the club members discussed what items to bake and agreed that there should be minimal waste because our club promoted waste-free lunches. In spite of this agreement, the student in this example always made desserts in nonrecyclable plastic cups and covered them with plastic wrap. Subsequently, the students who bought this dessert also had to use throw-away plastic spoons to eat it. In other aspects of her life, this student had made efforts to reduce her waste; therefore, she would have been correct to select the survey response that she chose.

When asked about climate change concerns, two-thirds of students replied that they were either very or somewhat concerned, a result that suggests this was a pressing topic for many of them. In spite of this expressed concern, the results for knowledge Item 24 revealed that 38% of the participants did not agree that the majority of scientists believe the current rate of climate change is real and human caused. Interestingly, all four respondents who indicated that they were *not* concerned about climate change at all did claim to know about the scientific consensus on the issue (Item 24). This outcome was interesting and unexpected and suggests that, even if someone possesses certain knowledge about the status of expert opinion on an issue, it does not mean they will necessarily agree with expert views. The topics related to climate change are covered in the *BC Science 10* (Sandner et al., 2008) textbook (Unit 4), but perhaps some of the students did not

remember having studied them 2 years before or perhaps they were not covered adequately in their classes.

In spite of these apparent deficiencies, the Surrey sample population performed better regarding the topic of climate change when compared to their American counterparts. The *Yale Project on Climate Change Communication* study, *American Teens' Knowledge of Climate Change*, showed that 33% of the respondents were very worried or somewhat worried about global warming (Leiserowitz, Smith, & Marlon, 2011, p. 8). These results are in contrast to the 68% of Surrey students who indicated that they were very concerned or somewhat concerned about climate change. Only 35% of the American teens understood that most scientists think global warming is happening (Leiserowitz et al., 2011, p. 8), whereas 62% of the Surrey respondents indicated that the majority of scientists believe that the current rate of climate change is real. Seven percent of the Yale study participants knew the amount of carbon dioxide in the atmosphere in parts per million (Leiserowitz et al., 2011, p. 2), whereas 18% of the Surrey students responded to this similar survey question correctly.

Responses to Knowledge-Based Items

In general, some of the students in this study performed quite well on Items 19 to 37, which were knowledge- rather than opinion-based; however, many students showed deficiencies in some areas. The first and most compelling result was found in the responses to Item 19, "What is the most abundant gas in our atmosphere?" It was quite surprising that so few of the respondents knew that nitrogen is the most abundant gas in the atmosphere since this is such a fundamental piece of scientific knowledge. If a student did not know the answer, oxygen would have been a logical guess as a possible answer, since it is an essential for human life and is also a

major component of the atmosphere. Nevertheless, the fact that over half of the respondents chose carbon dioxide as their answer was perplexing. Also, the percentage of correct responses was as high as it was because one participating secondary school (in Region 4; see Table 2) had a higher than average number of students respond correctly to this item. Sixty-one percent of the 18 students from Region 4 were able to correctly identify nitrogen as the most abundant gas in contrast to the overall 26% of total students who responded correctly among the rest of the survey respondents. For Item 20, 77% of the students did not know that water vapour is a greenhouse gas (they were asked to choose from carbon dioxide, nitrogen, water vapour, or methane). Surprisingly, although Region 4 students performed better on Item 19, only four students from this school responded correctly to Item 20. These results suggest that no relationship existed between responding correctly to Item 19 and responding correctly to Item 20 for this group of students. Out of the 93 respondents, only three students answered correctly to both Items 19 and 20. Nevertheless, it was not the intention of the project to compare and analyse the data from the schools from the five demographic areas. At no point did I indicate in my thesis proposal or in my recruitment statement to teachers that I intended to make such comparisons. Consequently I did not do any analysis beyond this general observation.

In addition to these response patterns and perhaps not as surprising, for Item 23, 71% of all students chose “I do not know” when asked about the current approximate global average proportion of carbon dioxide in the atmosphere (380–400 ppm), while another 11% responded with incorrect choices to this item. When you combine the results for student responses to Items 19, 20, 21, and 23, it is conceivable that the results suggest that it might be challenging for a considerable number of students to understand some of the basic components of climate change

science or to be able to read and critique articles and information about climate change issues. On the other hand, about two-thirds of the students were able to correctly recognize some of the observed changes that are claimed to be effects of climate change. Perhaps it is easier to identify such descriptive changes because they are more tangible and have been reported on more widely in the media whereas knowledge of some of the science and actual research evidence behind the changes to climate remains more elusive.

Although the concept of the ecological footprint is presumably taught in Science 10 with a page dedicated to it in the *BC Science 10* (Sander et al., 2008) textbook entitled “Reducing Your Ecological Footprint” (p. 152), in their responses to Items 27 and 28 approximately one third of the students admitted to not knowing the meaning of this term and an additional 62% answered incorrectly. This result suggests that 92% did not learn or did not recall this concept. Only 9% of respondents were able to correctly select 8.5 as the ecological footprint for someone living in Canada when asked, “The carbon footprint (also known as ecological footprint) of someone in Vietnam is approximately .76. What is the approximate carbon footprint for someone living in Canada?” Unfortunately, I was informed by the Science teacher who took my survey that students learn the concept carbon footprint and not ecological footprint. As a result, I incorrectly included the term carbon footprint for Item 27. In retrospect, the question would have been clearer if it also included the word hectares to be worded as follows: “What is the approximate **ecological footprint measured in hectares** for someone living in Canada?” However, given that 57 students chose the smaller ecological footprint suggests they thought Canadians are greener than they actually are.

Item 28, which referred to the Great Pacific garbage patch, an ecological degradation topic not covered by the Science 10 curriculum, was another knowledge question that showed a deficit. Over one third had never heard of it and an additional 43% did not know that its approximate size is larger than the area of Texas. Perhaps respondents would have answered correctly if a geographical comparison had been made to a Canadian region or province rather than an American state. Although this is a knowledge item in the sense that it asks students to recall numerical information about this issue, it might have been better to have simply asked them to indicate what they understood about plastic materials as pollution in the oceans and to have given them a set of general statements about the nature of the problem. The item could also simply have checked to see what students understood about the term, faced with several alternatives.

The results for survey Items 31, 32, and 35, which were based on species identification and related issues, showed some opportunity for improvements to student knowledge. Just over one third of students were unable to identify the Dogwood as BC's provincial flower. Possibly so few knew this because it is a specific question related to British Columbia rather than a question based entirely on science knowledge or facts about local natural history. A student who was a non-native of BC or born outside Canada, might not know BC's provincial flower or be expected to have knowledge of it. Out of the 45 students who indicated that they spoke a language or languages other than English at home, 49% were not able to correctly identify the Dogwood as BC's provincial flower. Out of the 48 students who indicated that English was the primary language spoken at home, 73% of these respondents answered correctly to this item. Of the 30 students who indicated that they spoke English and at least one other language at home, 50%

responded correctly to this item. These results suggest that students who indicated that English was not the primary language spoken at home, and those who spoke languages in addition to English at home, were less likely to know that the Dogwood is BC's provincial flower. In other words, it is possible that the item was an assessment of "cultural awareness" rather than knowledge of particular science content or local natural history.

For Item 33, 63% of students did not know that the major factor behind the Mountain Pine Beetle infestation was considered to be warmer winter temperatures. For Item 35, only 15% knew that the Monarch butterfly population was significantly reduced and threatened with most choosing the beaver or black bear instead. It is unlikely that these items of Canadian content would have been discussed in secondary classes outside of Science 10 or Biology 11 or 12.

The majority of the respondents performed very well on the last two knowledge-based items (Items 36 & 37), which required them to read and understand a food web diagram in which a grizzly bear was shown as the apex species. Perhaps the food web was a topic that was easily grasped and well taught both in elementary school and in their Science 10 classes, or possibly they did well because the answers were logical and the item was supported by a diagram.

Observed Differences between Male and Female Respondents

Overall there was a gender balance among the survey participants with only three more females than males. In general differences were not observed between most of the item responses for male and female participants. Nevertheless, some of the gender differences seen in the results are specifically worth mentioning. As earlier stated, two students did not indicate their gender. Their results are not included in the gender comparisons.

The first example of gender difference stems from the results for environmental club membership. Only 10 (11%) of the 93 respondents indicated that they had belonged to an environmental club and of these 10 respondents, six were female, three were male, and one did not indicate a gender. These results are not surprising based on my own observations as a secondary school environmental club teacher sponsor for over a decade. I would estimate that, over the years, at least 80% or more of the students in the club were female. When asked if they belonged to any clubs or organizations outside of school that had an environmental focus, 12 students (13%) replied that they had and 10 of those respondents were girls. These results suggest that secondary school girls are more likely than boys to engage in environmental clubs and organizations with an environmental focus, a result that I can confirm through my own experience.

As shown in Figure 9, the survey item in regard to concern about climate change (Item 16) showed a clear gender difference in responses with approximately twice as many females as males being “very concerned” about climate change.

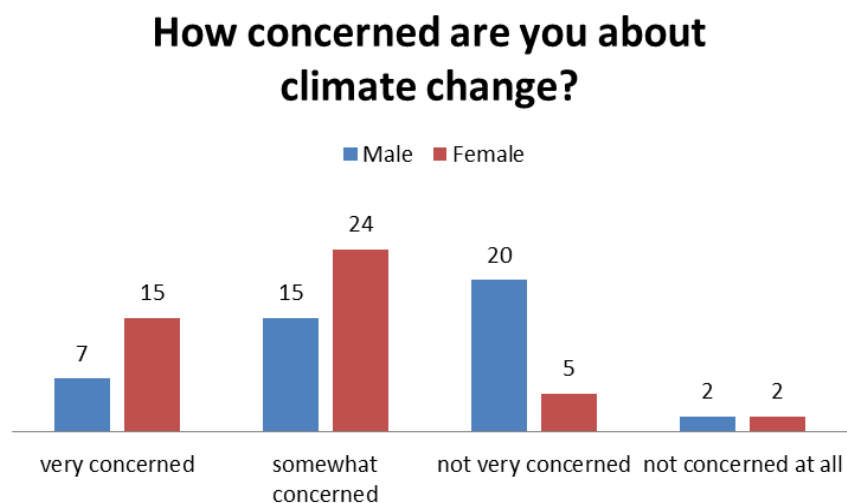


Figure 9. Male and female responses to Item 16: “How concerned are you about climate change?”

Another example of a gender difference in the survey responses can be found for Item 18: “Which of the following statements represents your personal views?” with the following choices: (a) growing the economy and job creation is more important than protecting the environment; (b) protecting the environment is more important than growing the economy and job creation; and (c) there should be a balance between growing the economy and job creation and protecting the environment.

None of the female respondents chose “a” as their response, but six males did select the “a” response. This outcome could be the result of boys having more exposure to the trades-related occupations in BC through apprenticeship and work experience programs compared to girls. Figure 10 shows the results for Item 18 according to gender.

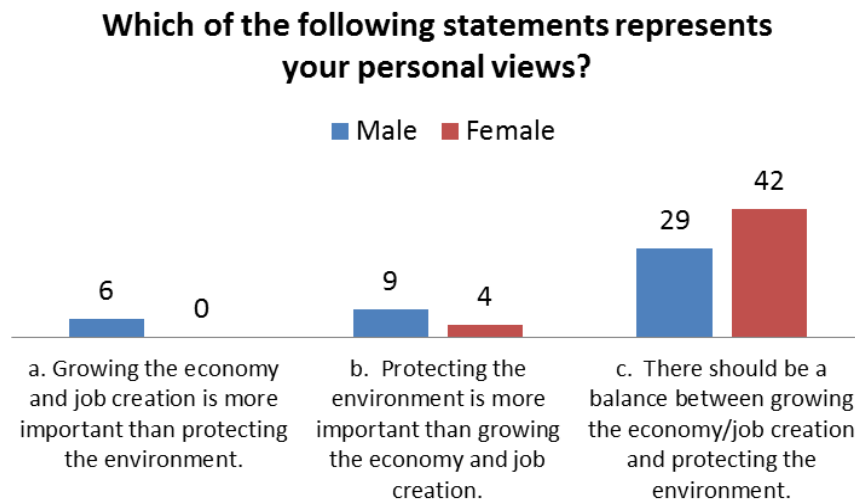


Figure 10. Male and female responses to Item 18, which asked participants their personal views on growing the economy and protecting the environment.

Item 24 asked, “Which of the following statements **best reflects** the current state of scientific opinion as summarized by the IPCC (Intergovernmental Panel on Climate Change)?” Seventy percent of the female respondents chose the correct answer, “The majority of scientists believe that the current rate of climate change is real and caused by human activity,” in contrast

to 55% of the males who chose this response. Almost twice as many males chose the response, “Some scientists believe that the current rate of climate change is real and caused by human activity.” The word “some” in this response option suggests a lower consensus among scientists concerning the causes of climate change.

Item 30 contained the question, “What plastics are **not** accepted into the City of Surrey’s residential recycling program?” Although 55% of students indicated that they did not know the answer, of the 16 who did answer correctly, 69% were female. Nevertheless, no difference existed between genders in the participants’ responses to Item 14b when students were asked to choose the statement that best described their recycling and waste reduction efforts at school and at home. These results suggest that more females recognized which types of plastics can be recycled in the City of Surrey, but in terms of participation rates for recycling and waste reduction, the results for males and females were the same.

The last item (Item 39) of the survey asked respondents to offer an opinion about the question, “How important is it to learn about ecosystems and environmental topics?” The responses to this item also showed a difference between the male and female survey participants. The majority of the students who chose “very important,” were female. None of the female respondents chose “not very important” or “not important at all,” in contrast to the seven males who did. Figure 11 shows the results for Item 39 according to gender.

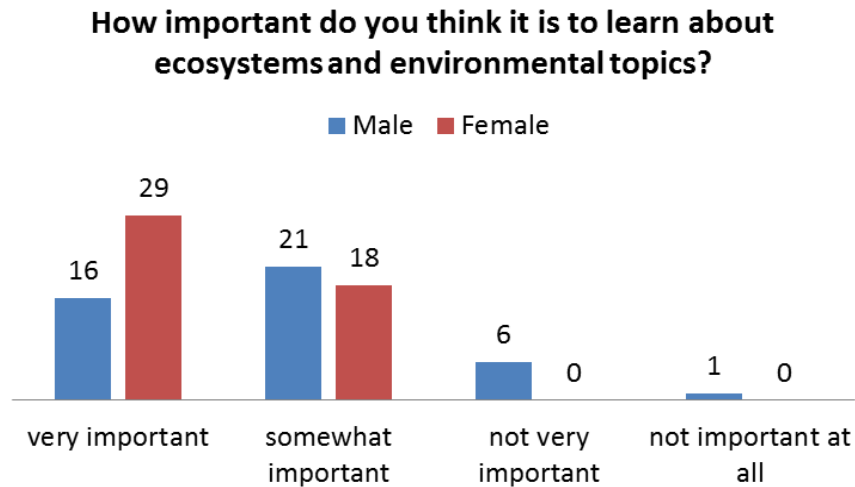


Figure 11. Male and female responses to Item 39, “How important do you think it is learn to learn about ecosystems and environmental topics?”

In summary, only some of the survey items elicited responses that showed a gender difference in the student responses. Among the sample population, female participants were more likely to have belonged to an environmental club at their secondary school and to a club or organization that had an environmental focus. The female respondents demonstrated greater concern when asked about climate change. More females indicated that they agreed a balance should exist between growing the economy and job creation and protecting the environment. Slightly more females than males agreed that the majority of scientists agree that the current rate of climate change is real and caused by human activity. In terms of recycling and waste reduction behaviours, the results indicated that there was no difference between males and females, although the females were more knowledgeable about the types of plastics that are recyclable. Last, slightly more female respondents than males (100% female vs. 84% males) responded to the survey that learning about ecosystems and environmental topics was very or somewhat important to them.

Environmental Club Participants

A total of 10 (11%) of all the students (male and female) indicated they had belonged to an environmental club at their secondary school. As previously mentioned, six of these students were females and three were male. The number of students belonging to an environmental club was about 10 times greater than expected; however, I am unable to explain this outcome. In the 2013/2014 school year, I contacted all 19 Surrey secondary schools to ask how many students were environmental club members, and I received responses from over half of the schools. On average, the clubs enrolled about 15 members, which, in a typical Surrey high school with a population of 1500, represents 1% of the school's population. The school where I have taught had a 2013/2014 school population of approximately 1550, and at that time, the club had at most 15 active members. Based on my experience, lack of interest and other school commitments seemed to prevent more students from joining the club.

Only 12 of the total population surveyed in this study responded "yes" when asked if they belonged to a club or organization outside of school that had an environmental focus. Surprisingly, only two of the 10 students who were involved in environmental clubs indicated that they also had such involvement outside of school. I expected the environmental club members to have had more opportunities to become involved in workshops organized by organizations, such as Metro Vancouver, the City of Surrey, or SD 36. SD 36 environmental club members are also privy to information regarding volunteer or paid work in environmental fields such as The Great Canadian Shoreline Cleanup, SHaRP (Salmon Habitat Restoration Project), Tynehead Salmon Hatchery, Operation Save H₂O, and the Vancouver Aquarium. As the sponsor teacher of the Environmental Club, I was the main contact person at my school to receive

information regarding environmental events and employment opportunities to be communicated to the club members. Perhaps the survey should have included a question regarding any environment-related work experiences that students may have had in order to determine if there was a broader scope of experiences that this study overlooked.

Overall, the students who were environmental club members did not perform better on the knowledge-based items of the survey with the exception of the last two knowledge-based survey items (Items 36 and 37), which were concerned with the interpretation of a food web diagram. None of the 10 environmental club members responded correctly to the ecological footprint question and only five knew the sort of plastics that were acceptable in the City of Surrey's residential recycling program. Less than half of this group of participants indicated that they understood the main factor claimed to be behind the BC Mountain Pine Beetle epidemic. All but two club students knew why pandas in China have become endangered, but surprisingly only one student belonging to an environmental club knew about causes of the decline of the Monarch butterfly. All of the students in this subgroup correctly placed the grizzly bear in the food web diagram, and all but one student correctly placed the salmon in the web. Not surprisingly, nine of the 10 students indicated that it was very important to learn about ecosystems and environmental topics, and one selected "somewhat important".

Biology 11 Student Results

Although the survey results for the 46 students who indicated that they had taken Biology 11 were analysed closely, this subgroup did not appear to respond any more effectively to the knowledge-based items compared to those who had not studied Biology 11. For example, of the 25 students who selected the correct option for Item 19, concerning the most abundant gas in the

atmosphere (nitrogen), only 16 of these respondents had taken Biology 11 with the remaining 30 Biology 11 students answering incorrectly. For Item 21, which inquired about the presence of methane, of the 54 students who responded correctly, only 25 were Biology 11 students. For Item 24, of the 58 students who indicated that the majority of scientists believe that climate change is real and caused by human activity, 33 of these respondents had studied Biology 11. For Item 28, out of the 34 students indicated they had never heard of the Great Pacific garbage patch in the Pacific Ocean 20 were Biology 11 students and out of the 18 students who responded they knew of its approximate size, 10 were from the Biology 11 subgroup.

Additionally, the Biology 11 students did not perform significantly better on the final two knowledge-based questions based on a food web diagram. For Item 36, of the 76 students who could correctly place the grizzly bear at the top of food chain, 39 were Biology 11 students. Of the 74 students who correctly placed the salmon in position #2 in Item 37, 39 were Biology 11 students. These results suggest that students who had only taken Science 10 performed similarly to the Biology 11 students on the knowledge-based items.

For Item 38, that asked students how well they felt their high school education had equipped them to understand basic ecological knowledge and environmental problems, 35 students responded “not very adequately” or “not adequately at all” and 19 of these students had taken Biology 11. For Item 39, of the 86 students who indicated that it was “very important” or “somewhat important” to learn about ecosystems and environmental topics, 45 were Biology 11 students and one Biology 11 student chose not very important. The results for the students who had taken Biology 11 showed that they did not appear to perform better on the knowledge-based items. This finding suggests that even though some students choose to study Biology 11, the

course material covered in Biology 11 may give them no advantage in regards to attaining environmental and ecological knowledge when compared to students who only study Science 10.

Limitations of the Study

The sample size was a limitation of the study. SD 36 is the largest in the province, and it is likely one of the most varied districts in terms of the demographics of socio-economics and ethnic diversity. I wanted to ensure that the survey involved Grade 12 students who were representative of the whole district so I made the decision to try to sample a range of students from multiple regions and backgrounds. I also was dealing with a group of minors who could only be surveyed with parental consent. As a result of this requirement, it was only logistically possible to recruit and sample a relatively small group of participants from each of the five chosen schools. My goal was to survey Grade 12 students from five secondary schools representing the five different demographic regions of Surrey based on the Barager ThemeMap (see Appendix A). As I was relying on compliance from teacher sponsors to recruit students, in addition to the parental consent issue, I had difficulty predicting the number of students who would participate. Ultimately what resulted was a sample of convenience. I invited all the potentially eligible English teachers to participate and six participants were willing to become involved. Each of the five demographic areas had teachers who were willing to participate, even though it is possible that they might not be fully representative as they were not chosen randomly. Although an unequal distribution of students per demographic region resulted, I decided that an outcome of 93 students (62% of the recommended potential of 150 students) was adequate. A larger population would have been ideal, but organizing and recruiting more participants would have been more challenging. Furthermore, the additional data would have

been prone to human error in the manual processing and recording of a larger number of paper-based, hard copy surveys. As previously discussed, working with a hard copy, paper-based survey instead of an online format presented some challenges.

An additional study limitation, albeit minor, related to the number of response choices in the survey. As much as possible, four response options were created for each question, a format consistent with that of the BC Provincial Exams and one with which students can be expected to be familiar. This format was suitable to ensure that questions were not too easy and it also helped prevent the possibility of the survey becoming too long and requiring too much reading for every item. Nevertheless, although it would have been preferable to have the same number of response options for all survey items, it was necessary to utilize five or more response options for six of the knowledge-based items (Items 22, 24, 25, 27, 31, and 32) in order to avoid making the questions too easy. In spite of this variation, the possible response choices were kept to single words or short phrases to avoid confusion and reader fatigue.

Overall some of the survey items could have been strengthened to ensure greater clarity. For example, as previously mentioned, in Item 28 I used the term carbon footprint incorrectly. Unfortunately this error was not picked up by others prior to the distribution of the survey packages. In Item 23, I did not include examples of an appreciation for nature and non-human species—a potential flaw.

Last, in designing my survey items, I could have drawn from a wider sample of similar environmentally-based surveys such as PISA or the Pew Research Center, but did not do so because I wanted to create a survey that was unique to BC students by including items that were related to the Ministry required BC Science 10 curriculum and *BC Science 10* textbook.

Furthermore, I chose to use both opinion- and knowledge-based items because I wanted to explore possible connections between behaviours, opinions, and knowledge related to environmental topics such as climate change.

Conclusions and Recommendations

In completing this project, I learned many things in terms of methodology and the development of research questions. First, if I were to do things over, I would like to have a stronger grasp of the terms environmental literacy, ecological literacy and ecoliteracy prior to creating the student survey. I did not encounter the McBride et al. (2013) article proposing and discussing the distinctions among these literacies until several months after the survey had been completed by the participants. I might have designed the survey differently had I read the McBride et al. article prior to creating the questions.

Further, after I designed the survey, only six people reviewed my survey question: my thesis supervisor; a writer of the *BC Science 10* textbook (2008), who was also a science teacher at my school; and four students had reviewed my survey questions. As an experienced exam writer for the BC Ministry of Education, I understand that designing strong items can be a lengthy and complex process. I should have collaborated with more people to assist in designing my survey items. It would have been beneficial to solicit feedback from other Science 10 teachers in the Surrey District and teachers who share an interest in EE, including members of the Environmental Educators' Provincial Specialist Association. I am quite certain that if I had involved more Science 10 teachers and environmental educators in the development phase of my survey, I might have avoided some of the weaknesses I outlined in the Limitations Section.

Ideally I would have preferred a larger, randomly selected sample population to complete the survey. This would have been facilitated by using an online survey tool or template. Not only would this have allowed me to work with a more representative population of SD 36 students, but the convenience of using an online survey would have made processing, analyzing, and interpreting the data more efficient. As previously discussed, it was difficult for me to recruit a larger sample population for this research project and it was not practical to use an online survey format.

This was a relatively small-scale polling study; therefore, I am hesitant to make broad generalizations that apply to the BC education system as a whole. Nevertheless, this project provides some useful findings about the sample of Grade 12 Surrey students who participated. Based on the findings, almost half the students claimed not to spend a significant amount of time in the outdoors and it was not common for students to experience school-based field trips in outdoor settings. Although roughly two-thirds of the students indicated that they were concerned about climate change, the majority did not have some elements of basic knowledge commonly associated with understanding climate change science nor did they appreciate the nature of the consensus among scientists concerning the causes of climate change. Overall, in terms of the ecological and environmental knowledge-based questions, the majority of students responded incorrectly to almost half of the survey items. These results suggest that these students may lack sufficient knowledge commonly associated with the construct of environmental literacy. Although approximately one third of students expressed an opinion that their high school education had not adequately equipped them to understand basic ecological knowledge and environmental problems, the results for the knowledge-based questions, suggest that closer to

two-thirds were not adequately equipped. Nevertheless, the majority of the students indicated that learning about ecosystems and environmental topics was important.

As a starting point, in order to address the low participation rates in outdoor experiences uncovered by the survey, I would recommend that SD 36 create more outdoor learning opportunities for all secondary students regardless of what subjects they study or clubs they may join. In a recent Canadian Broadcasting Corporation article (Gallagher, 2015), UBC Education Faculty member Hartley Banack enthusiastically advocated for students to get out of their classrooms and into the outdoors to engage in experiential learning. Banack noted that research has shown that the benefits of outdoor learning include improved physical health, stress reduction around learning disabilities, and community building (Gallagher, 2015). Banack organized a first-of-its-kind outdoor education festival called Wild About Vancouver in April 2015, which “offers free classes in everything from beekeeping to kayaking to permaculture” (Gallagher, 2015, para. 4) and also provides workshops for teachers. SD 36 could look to this festival to gain valuable insights and possibly organize its own outdoor education festival with the guidance of Environmental Educators’ Provincial Specialist Association and Wild About Vancouver organizers.

Furthermore, if EE topics are to be included in more secondary courses and within a school’s culture, then it would be necessary to also provide Surrey teachers with adequate professional development opportunities to allow them to gain an understanding of the importance of including EE content and the skills necessary to feel competent and confident in including environmental topics in their lessons. Even though there are valuable EE resources available to teachers, including the *Environmental Learning and Experience* document (BC MoE, 2007), it is

my belief that most BC teachers are unaware of the existence of these resources, especially if they do not have a particular interest in including environmental topics in their lessons. Even though I am passionate about EE, I have often had teaching loads that included four to six different courses across three or four departments. The amount of time required to do proper preparation allows little time or energy to explore EE resources. I highly doubt that typical mainstream secondary teachers in Surrey are actively seeking out EE resources if they already have heavy teaching assignments and little time to spare.

As of April 2015, there were only 170 active Environmental Educators' Provincial Specialist Association members in the entire province of BC and only four of these were listed as Surrey teachers (L. Primeau, personal communication, April 22, 2015). This small membership is somewhat worrisome considering that Surrey is the largest district in the province. It also suggests that mainstream Surrey teachers may not have an interest in EE. Workshops could be offered by Environmental Educators' Provincial Specialist Association to entire Surrey staff populations on professional development⁵ days in order for teachers to gain an understanding of the importance of developing environmental literacy and to find ways to integrate EE topics into their lessons.

Of course there will always be teachers (as well as administrators and parents) who do not recognize the importance or relevance of EE to their specific secondary programs or subject areas. It seems that a one-size-fits-all approach is always a challenge when implementing new

⁵ I have experienced a variety of activities and workshops organized by SD 36, my school's Professional Development Committee and by our administration. If we have the time, money and resources to participate in professional development on how to use Twitter® in our classrooms (which I personally did not benefit from), then surely the District can find money and resources to support EE related professional development.

forms of teaching practices. In January 2011, the Simon Fraser University Faculty of Education implemented a pilot preservice teacher education program with an emphasis on environmental education. The SEEDs (Sustainability Education in an Environment of Diversity) cohort consisted of 32 student teachers enrolled in an intensive 12-month teacher certification program. A recent paper reflecting on the experiences of the SEEDs' preservice teachers and faculty members found that, although their overall experiences were positive, many of them faced challenges (Ormond, Zandvliet, McClaren, Robertson, Leddy, & Metcalfe, 2014). Some of the constraints encountered by the SEEDS student teachers included a lack of support from their placement schools' administrations, faculty, and/or school associates or the overall school culture. As a result, some of the participants remarked that implementing EE in their classroom was more difficult than they had anticipated (Ormond et al., 2014). Ormond et al. (2014) concluded that the implementation of progressive teaching practices related to EE continues to be a challenge. It is my belief that both new and experienced teachers need to be supported and be given the skills to feel competent in order to deliver EE effectively and meaningfully.

On a personal level, my experiences as the Environmental Club sponsor teacher at my school have often left me feeling alone and isolated. With approximately 15 students in the club and with little interest from other staff members to get involved, the role of being seen as the "green teacher" has often been a lonely path for me. I need to accept that although I can only achieve so much as an individual teacher, many other educators in my district and in BC who are doing amazing things. I personally need to do more to connect with those who support and share my passion for EE, rather than focus on things that impede my efforts.

Closing Thoughts

A few months after the birth of my daughter, I went to visit my school. I was really touched when the Grade 12 members of our Environmental Club presented me with a mini bonsai rock garden they had made out of recycled paper and an album full of photos showing us participating in various club activities over a 4-year period. The thoughtful and kind messages they left for me in the album reminded me that the volunteer work I had been doing with them had really mattered, even though I often worried that it was not enough.

Thomashow (1995), in *Ecological Identity*, wrote that four foundational questions make up environmental education, yet they are frequently overlooked:

- Where do the things that I consume come from?
- What do I know about the place where I live?
- How am I connected to the earth and other living things?
- What is my purpose and responsibility as a human being? (pp. 179–180)

These key questions are not just relevant to EE curricula but to the broader scope of education as a whole. They are extremely important questions that are fundamentally tied to what it means to be human and to directly correlate to our existence on Earth. Schools need to create opportunities for both elementary and secondary students to contemplate such big ideas during their educational paths. It is imperative that those who are in a position to redesign the BC curriculum make EE a priority rather disregard it or leave it up to a small number of individuals such as myself to fit it into extracurricular activities.

Over two decades ago, McClaren (1992) identified the problem of EE inclusion in the BC education system and argued that EE should not be viewed as a separate or distinct course, but

should surface in a variety of subject areas (p. 7). When I consider the current challenges of implementing EE and outdoor learning experiences in the BC curriculum (Caner, 2009; Robertson, 2007), it often seems like little has changed since the writing of McClaren's article. After completing this project, I have also come to the conclusion that the BC Education system cannot rely on a few isolated courses, such as Science 10, to adequately equip secondary school students with EE related knowledge and experiences. Rather than include a lot of environmental content in only a few secondary courses, both BC Ministry required courses and elective courses could include smaller chunks to widen the scope of EE experiences as suggested in the *Environmental Learning and Experience* (BC MoE, 2007) document. For secondary students who develop a strong curiosity for EE, intensive environmental studies, sustainability courses, and district programs could be offered to meet their needs.

In closing, in order to nurture and develop environmental literacy among BC youth, educators must first place value on learning about our natural world and acknowledge the pivotal role humans possess in shaping the planet—for better or for worse. Caring for the planet and learning about ecosystems and environmental topics should be standard topics to be included in both the elementary and secondary curricula. Educators, administrators, students, parents, governments, and environmentalists all have a role in shaping the BC education system to ensure environmental education adequately exists at the elementary and secondary levels. The findings of this research can serve as a resource for SD 36 and the BC Ministry of Education to help improve the status of environmental literacy among secondary students. It is my hope that the inclusion of environmental topics will be taken more seriously and that decisions and programs regarding EE implementation at the secondary level will be further improved.

References

- Alberta Education. (2010). *Inspiring education: A dialogue with Albertans*. Retrieved from <https://ideas.education.alberta.ca/media/14847/inspiring%20education%20steering%20committee%20report.pdf>
- Alberta Ministry of Education. (2013). *Ministerial order (#001/2013)*. Retrieved from http://education.alberta.ca/media/6951645/skmbt_c36413050707450.pdf
- Alberta Regional Consortia. (2013a). *An educated Albertan*. Retrieved from http://www.arpc.ab.ca/pdf/MinisterialOrderPoster_English%20Final%2011x17.pdf
- Alberta Regional Consortia. (2013b). *Ministerial order on student learning*. Retrieved from <https://ideas.education.alberta.ca/media/14847/inspiring%20education%20steering%20committee%20report.pdf>
- BC Ministry of Education. (2007). *Environmental learning and experience: An interdisciplinary guide for teachers*. Retrieved from http://www2.gov.bc.ca/gov/DownloadAsset?assetId=CC9FBABCD8B442A5A5B29737E5246E79&filename=environ_learning_exper.pdf
- BC Ministry of Education. (2008). *Science Grade 10 integrated resource package*. Retrieved from http://www.bced.gov.bc.ca/irp/pdfs/sciences/2008sci_10.pdf
- BC Ministry of Education. (2009). *The environmental learning and experience curriculum maps*. Retrieved from http://www2.gov.bc.ca/gov/DownloadAsset?assetId=235B3121C9DB4F51A3BF42A878D06F0C&filename=ele_maps.pdf

BC Ministry of Education. (2011). *BC education plan*. Retrieved from

http://www.bcedplan.ca/assets/pdf/bc_edu_plan.pdf

BC Ministry of Education. (2013). *Area of learning: Science draft curriculum*. Retrieved

February 20, 2014 from

https://curriculum.gov.bc.ca/sites/curriculum.gov.bc.ca/files/pdf/s_learning_standards.pdf

BC Ministry of Education. (2015). *K–9 revised big ideas for science*. Unpublished manuscript.

Brown, L. (2007, December 4). Teens pessimistic about environment. *The Star*. Retrieved from

http://www.thestar.com/news/gta/2007/12/04/teens_pessimistic_about_environment.html

#

Caner, C. (2009). *A review of outdoor learning in British Columbia's public schools* (Master's thesis). Retrieved from

<http://search.proquest.com.ezproxy.royalroads.ca/docview/880574949/165F2A126FF94B8BPQ/31?accountid=8056>

Capra, F. (1996). *The web of life*. New York, NY: Anchor/Doubleday Dell.

Capra, F. (2005). *Ecological literacy: Educating our children for a sustainable world*. San Francisco, CA: Sierra Club Books.

Carbon Dioxide Information Analysis Centre. (2010). *Ranking of the world's countries by 2010 per capita fossil-fuel CO2 emission rates*. Retrieved from

<http://cdiac.ornl.gov/trends/emis/top2010.cap>

Carson, R. (1962). *Silent spring*. New York, NY: Houghton Mifflin.

Center for Ecoliteracy. (2015). *Teach*. Retrieved September 12, 2014 from

<http://www.ecoliteracy.org/teach>

Chung, E. (2014, August 28). Canadians' science literacy ranks 1st among 35 countries. *CBC News*. Retrieved from [http://www.cbc.ca/news/technology/canadians-science-literacy-](http://www.cbc.ca/news/technology/canadians-science-literacy-ranks-1st-among-35-countries-1.2749413)

[ranks-1st-among-35-countries-1.2749413](http://www.cbc.ca/news/technology/canadians-science-literacy-ranks-1st-among-35-countries-1.2749413)

City of Surrey. (2015). *About Surrey*. Retrieved from <http://www.surrey.ca/3547.aspx>

City of Surrey. (2015b). *Population estimates and projections*. Retrieved from

<http://www.surrey.ca/business-economic-development/1418.aspx>

Council for Environmental Education. (n.d.). *Project wild*. Retrieved from

<http://www.projectwild.org>

Council of Canadian Academies. (2014a). *Science culture: Where Canada stands*. Retrieved

from

http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/science-culture/scienceculture_fullreporten.pdf

Council of Canadian Academies. (2014b, August). *Canadians rank highly when it comes to public science knowledge, attitudes, and engagement, finds Expert Panel* [News release].

Retrieved from

http://www.scienceadvice.ca/uploads/eng/assessments%20and%20publications%20and%20news%20releases/science-culture/scienceculture_newsrelease_en.pdf

Council on Environmental Quality. (1970). *The first annual report of the Council on*

Environmental Quality, together with the President's message to Congress. Washington,

DC: U.S. Government Printing Office.

Dowling, K. (2014). *New curriculum ignores the outside world, shortchanges students.*

Retrieved from <http://www.sierraclub.bc.ca/media-centre/press-clips/opinion-new-curriculum-ignores-outside-world-shortchanges-students>

Eisner, E.W. (1985). *The educational imagination* (2nd ed.). New York, NY: Macmillan.

Environmental Education Act. U.S. Public Law 91-516. (1970). Retrieved from

<http://www.gpo.gov/fdsys/pkg/STATUTE-84/pdf/STATUTE-84-Pg1312.pdf>

Eveleth, R. (2013, April). Highly recommended: Teaching climate change and evolution in science class. *Smithsonian.com*. Retrieved from <http://www.smithsonianmag.com/smart-news/highly-recommended-teaching-climate-change-and-evolution-in-science-class-19172466/?no-ist>

Gallagher, M. (2015, April 16). UBC education expert says kids benefit from learning outdoors.

CBC News. Retrieved from <http://www.cbc.ca/news/canada/british-columbia/ubc-education-expert-says-kids-benefit-from-learning-outdoors-1.3034839>

Goleman, D., Bennett, L., & Barlow, Z. (2012). *Ecoliterate: How educators are cultivating emotional, social, and ecological intelligence*. San Francisco, CA: Jossey-Bass.

Goodlad, J. (1984). *A place called school*. New York, NY: McGraw-Hill.

Green Party of BC. (n.d.). *Meet Andrew Weaver, elected MLA and deputy leader*. Retrieved from

http://www.greenparty.bc.ca/elected_mla

Hungerford, H. R., & Peyton, R. B. (1980). A paradigm for citizen responsibility: Environmental action. Paper presented at the Ninth Annual Conference of the National Association for Environmental Education, Albuquerque, NM.

- Johnston, J. (2009). *Transformative environmental education: Stepping outside the curriculum box*. Retrieved from <http://cjee.lakeheadu.ca/index.php/cjee/article/view/893/556>
- Kilian, C. (2010, May 12). BC's biggest school district faces cuts as enrolment grows. *The Tyee*. Retrieved from <http://thetyee.ca/News/2010/05/12/SurreySchoolsFaceCuts/>
- Krebs, R. E. (1999). *Scientific development and misconceptions throughout the ages*. Westport, CT: Greenwood Press.
- Leedy, P. D., & Ormrod, J. E. (2013). *Practical research: Planning and design* (10th ed.). Boston, MA: Pearson.
- Leiserowitz, A., Smith, N., & Marlon, J. R. (2011). *American teens' knowledge of climate change*. Retrieved from <http://environment.yale.edu/climate-communication/files/American-Teens-Knowledge-of-Climate-Change.pdf>
- Literacy. (2015). In *Merriam-Webster dictionary*. Retrieved from <http://www.merriam-webster.com/dictionary/literacy>
- McBride, B.B., Brewer, C. A., Berkowitz, A. R., & Borrie, W. T. (2013). Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here? *Ecosphere*, 2(5), 1–20. doi:10.1890/ES13-00075.1
- McClaren, M. (1992). Environmental literacy: A critical element of a liberal education for the 21st century. *Provincial Intermediate Teacher's Association*, 1992(Summer).
- McClaren, M. (2012). Thinking about curriculum [Word document]. Retrieved September 10, 2012, from Royal Roads University EECO 508 Lecture Notes Online <https://moodle.royalroads.ca/>

- McClaren, M., & Hammond, B. (2005). Integrating education and action in environmental education. In E. A. Johnson & M. J. Mappin (Eds.), *Environmental education and advocacy: Changing perspectives of environmental education*. New York, NY: Cambridge University Press
- Morrone, M., Mancini, K., & Carr, K. (2001). Development of a metric to test group differences in ecological knowledge as one component of environmental literacy. *Journal of Environmental Education*, 32(4), 33.
- Munson, B. H. (1994). Ecological misconceptions. *Journal of Environmental Education*, 25(4), 30–34.
- Next Generation Science Standards. (2013a). *The need for new science standards*. Retrieved September 28, 2014, from <http://www.nextgenscience.org/overview-0>
- Next Generation Science Standards. (2013b). *Topical arrangements for standards*. Retrieved September 28, 2014, from http://www.nextgenscience.org/search-standards?tid_1%5B%5D=15
- Odum, E. P. (1992). Great ideas in ecology for the 1990s. *BioScience*, 42(7), 542–545.
- OECD. (n.d.). *What makes PISA different*. Retrieved from <http://www.oecd.org/pisa/aboutpisa>
- OECD. (2007). *PISA 2006: Science competencies for tomorrow's world—Executive summary*. Retrieved from <http://www.oecd.org/pisa/pisaproducts/39725224.pdf>
- OECD. (2013a). *PISA 2012 Assessment and analytical framework*. Retrieved from http://www.oecd-ilibrary.org/education/pisa-2012-assessment-and-analytical-framework_9789264190511-en

- OECD. (2013b). *Canada: Student performance (PISA 2012)*. Retrieved from <http://gpseducation.oecd.org/CountryProfile?primaryCountry=CAN&treshold=10&topic=PI>
- Ormond, C., Zandvliet, D., McClaren, M., Robertson, P., Leddy, S., & Metcalfe, S. (2014). Environment education as teacher education: Melancholic reflections from an emerging community of practice. *Canadian Journal of Environmental Education, 19*, 160–179.
- Orr, D. (1992). *Ecological literacy: Education and transition to a postmodern world*. Albany, NY: State University of New York.
- PISA. (2006). *Student questionnaire for PISA 2006*. Retrieved from http://pisa2006.acer.edu.au/downloads/PISA06_Student_questionnaire.pdf
- Province of British Columbia. (2014). *The school act mandate for the school system*. Retrieved from https://www.bced.gov.bc.ca/legislation/schoollaw/d/oic_1280-89.pdf
- Robertson, P. (2007). *Sustaining the river: A grounded theory exploration of the bridges and barriers to environmental education in British Columbia* (Master's thesis). Retrieved from <http://search.proquest.com.ezproxy.royalroads.ca/docview/304720246/165F2A126FF94B8BPQ/16?accountid=8056>
- Roth, C. E. (1968). On the road to conservation. *Massachusetts Audubon, June 1968*, pp. 38–41.
- Sandner, L., Fatkin, F., Lacy, D., Martha, J., Milross, J., & Naso, K. (2008). *BC Science 10*. Toronto, ON, Canada: McGraw-Hill Ryerson.
- Sanera, M., & Shaw, J. S. (1996). *Facts not fear: A parent's guide to teaching children about the environment*. Washington, DC: Regnery.

Semeniuk, E. (2014, August 28). Is Canada a nation of science geeks? *The Globe and Mail*.

Retrieved from <http://www.theglobeandmail.com/technology/science/is-canada-a-nation-of-science-geeks/article20229020/>

Sierra Club BC. (2014). *Draft curriculum shortchanges students by cutting out environment*.

Retrieved from <http://www.sierraclub.bc.ca/education/draft-curriculum-shortchanged-students>

Stapp, W. B. (1969). The concept of environmental education. *Environmental Education*, 1(1), 30–31.

Stapp, W. B. (1970). The concept of environmental education. *The American Biology Teacher*, 32, 14–15.

Surrey School District. (2013). *Surrey School District guide to schools*. Surrey, BC, Canada: Author.

Thomashow, M. (1995). *Ecological identity*. Cambridge, MA: MIT Press.

UNESCO. (1975). *The Belgrade Charter: A global framework for environmental education*.

Retrieved from <http://unesdoc.unesco.org/images/0001/000177/017772eb.pdf>

UNESCO. (1977). *Intergovernmental Conference on Environmental Education: Tbilisi (USSR)*.

Retrieved from <http://unesdoc.unesco.org/images/0003/000327/032763eo.pdf>

UNESCO. (1978). The role, objectives and characteristics of environmental education. *Connect: UNESCO-UNEP Environmental Education Network*, 3(1), 1–8.

United Nations Environment Programme. (1972). *Declaration of the United Nations Conference on the Human Environment*. Retrieved from

<http://www.unep.org/Documents.Multilingual/Default.asp?documentid=97&articleid=1503>

United Nations Sustainable Development. (1992). *United Nations Conference on Environment & Development: Agenda 21*. Retrieved from

<https://sustainabledevelopment.un.org/content/documents/Agenda21.pdf>

University of Michigan. (2001, May). "*Founder of environmental education*" has died [News release]. Retrieved from <http://ns.umich.edu/Releases/2001/May01/r053101b.html>

University of Victoria. (2007, October). *UVic congratulates Nobel Prize-winning researchers* [News release]. Retrieved from

<http://communications.uvic.ca/uvicinfo/announcement.php?id=201>

Weaver, A. (2011). *Generation us: The challenge of global warming*. Victoria, BC, Canada: Orca Books.

World Commission on Environment and Development. (1987). *Our common future*. Retrieved from <http://www.un-documents.net/our-common-future.pdf>

Appendix A: Baragar ThemeMap

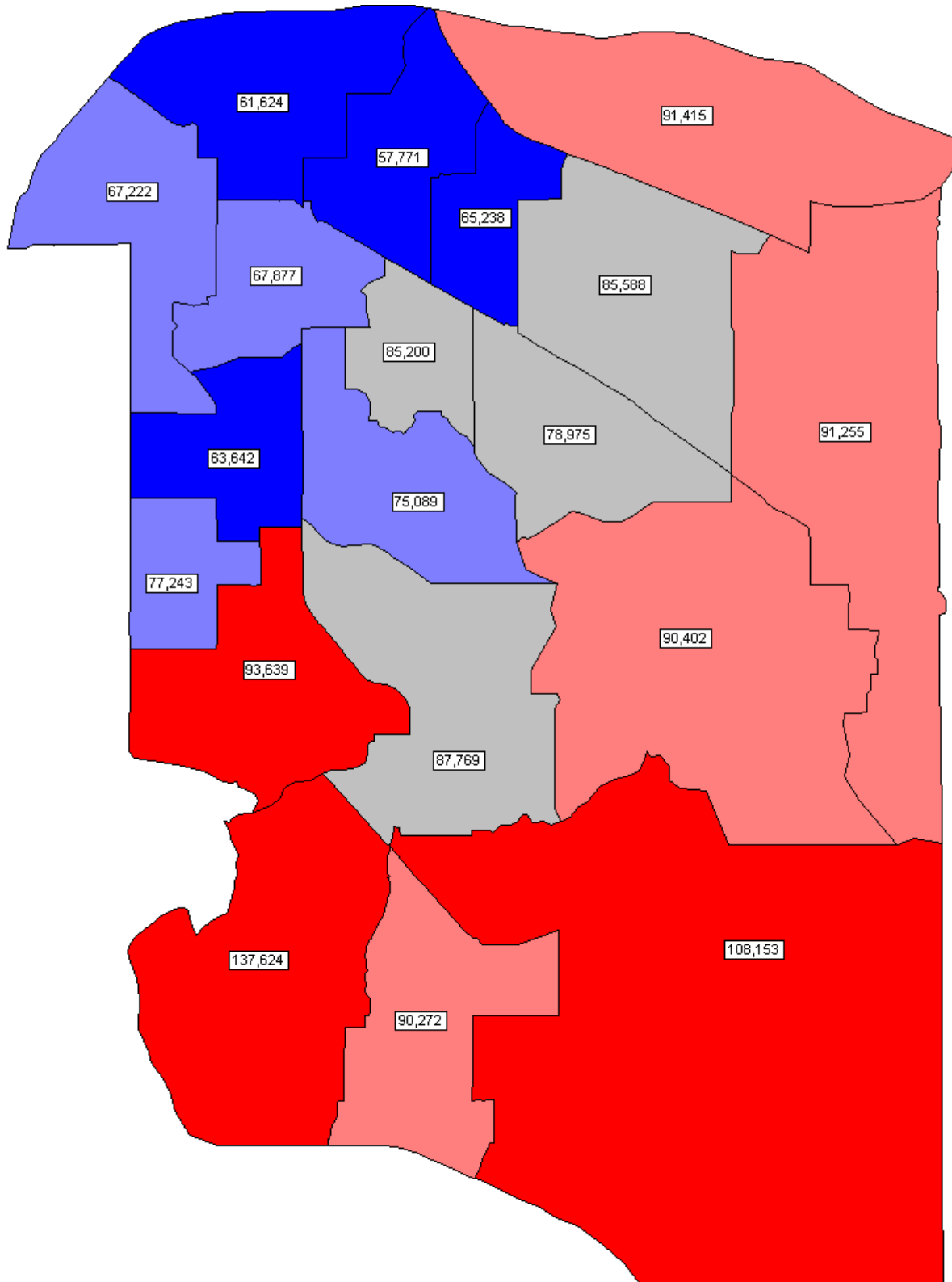


Figure A-1: Average income census 2006 from Baragar Ltd. The 2006 census shows the average income of the 19 secondary school catchments.

Note: Reprinted with permissions from School District 36.

Region 1 blue–lowest income

Region 2 light blue–lower middle income

Region 3 grey–middle income

Region 4 pink–upper income

Region 5 red–highest income

Appendix B: Ecoliteracy Survey

Thank you for your participation—your time is greatly appreciated. Please use dark pen to circle your answers but do not write your name anywhere on this survey. You have the option to stop the survey at any time. If you do not complete the survey the results will not be used in the research. Please answer the questions truthfully and to the best of your knowledge, without accessing outside assistance or resources.

1. What is your gender? M F
2. What is the **main language(s)** spoken by you and your family at home?
 - o English
 - o Chinese
 - o Tagalog
 - o Vietnamese
 - o Punjabi
 - o Hindi
 - o Arabic
 - o Lao
 - o Spanish
 - o French
 - o Other_____
3. Which of the following statements best describes your educational history?
 - a) I have spent Grades 8 to 12 at the same secondary school in Surrey.
 - b) I have spent Grades 8 to 12 at more than one Surrey secondary school.
 - c) I have spent Grades 8 to 12 both in Surrey and at other BC secondary schools.
 - d) I have spent at least two years studying in another province.
 - e) I have spent at least two years studying outside of Canada.
4. Did you or do you belong to an environmental club at your secondary school? **Yes No**
5. Did you or do you belong to any clubs or organizations outside of school that have an environmental focus (i.e., Scouts, Girl Guides, Outward Bound)? **Yes No** If yes, which one(s)? _____
6. Did you take Science 10 in BC? **Yes No**
7. Have you studied or are you currently studying Biology 11? **Yes No**
8. Have you studied or are you currently studying a secondary course with an environmental education focus (i.e., Sustainability, Environmental Leadership)? **Yes No** If yes, which one(s)? _____

9. How often do you spend time in the outdoors/a natural setting (i.e., park, forest, lake, river or ocean)?
- never or almost never
 - a few times a year
 - at least once a month
 - about once a week
 - more than once a week
10. How often have you participated in **field trips organized by your secondary school** that take place in the outdoors/ in a natural setting?
- never
 - once or twice
 - more than twice
 - at least once a year
11. Which of the following outdoor activities **have you tried in the past?** (circle all that apply)
- hiking, trail running, nature walks
 - tent camping
 - RV camping
 - kayaking, canoeing
 - rock climbing, mountaineering
 - snowshoeing, cross country skiing, back country skiing, outdoor ice skating
 - downhill skiing, snowboarding
 - cycling, mountain biking
 - surfing, windsurfing, wake boarding
 - hunting, fishing
 - swimming in ocean, lake, river
 - orienteering
 - nature photography/art work in the outdoors
12. Which of the following outdoor activities would you **want to try?** (feel free to rank with a number)
- __hiking, trail running, nature walks
 - __tent camping
 - __RV camping
 - __kayaking, canoeing
 - __rock climbing, mountaineering
 - __snowshoeing, cross country skiing, back country skiing, outdoor ice skating
 - __downhill skiing, snowboarding
 - __cycling, mountain biking
 - __surfing, windsurfing, wake boarding
 - __hunting, fishing
 - __swimming in ocean, lake, river

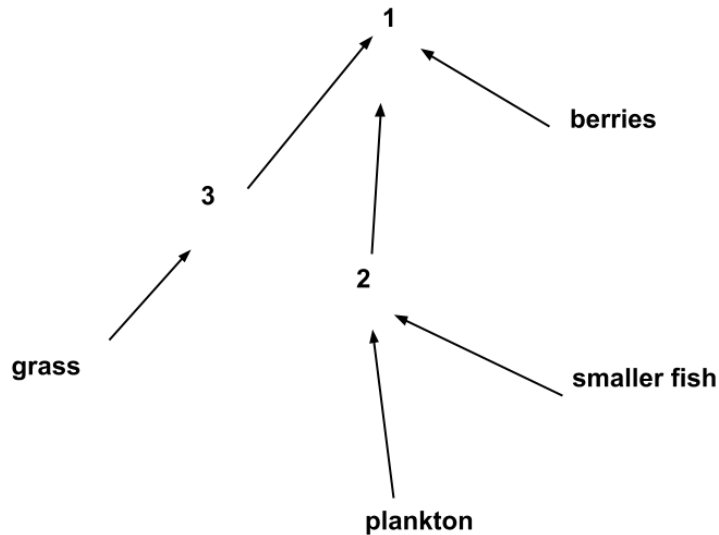
- l) ___orienteering
 - m) ___nature photography/art work in the outdoors
 - n) ___none
13. The overall culture of my secondary school promotes behaviours and attitudes that support green practices such as recycling, waste/garbage reduction, and energy conservation.
- a) I strongly agree with this statement.
 - b) I somewhat agree with this statement.
 - c) I somewhat disagree with this statement.
 - d) I disagree with this statement.
14. The overall school culture of my secondary school classes promotes behaviours and attitudes that support an appreciation for nature and non-human species.
- a) I strongly agree with this statement.
 - b) I somewhat agree with this statement.
 - c) I somewhat disagree with this statement.
 - d) I disagree with this statement
15. How often do you think about where your garbage ends up?
- a) frequently
 - b) sometimes
 - c) not very often
 - d) never
14. Which of the following statements **best** describes your behaviour?
- a) I make an effort to recycle and reduce my waste both at home and at school.
 - b) I make an effort to recycle and reduce my waste at home but not at school.
 - c) I make an effort to recycle and reduce my waste at school but not at home.
 - d) I rarely/never make an effort to recycle or reduce my waste at home or at school.
16. How concerned are you about climate change?
- a) very concerned
 - b) somewhat concerned
 - c) not very concerned
 - d) not concerned at all
17. In 2007, the BC government created targets to reduce greenhouse gas emissions by 2020 by at least 33% lower than the 2007 levels. How likely do think these targets will be met?
- a) very likely
 - b) somewhat likely
 - c) not very likely
 - d) not likely at all

18. Which of the following statements represents your personal views?
- a) Growing the economy and job creation is more important than protecting the environment.
 - b) Protecting the environment is more important than growing the economy and job creation.
 - c) There should be a balance between growing the economy/job creation and protecting the environment.
19. What is the most abundant gas in our atmosphere?
- a) carbon dioxide
 - b) oxygen
 - c) nitrogen
 - d) argon
20. Which of the following is **not** a greenhouse gas (GHG)?
- a) carbon dioxide
 - b) nitrogen
 - c) water vapour
 - d) methane
21. Which gas is known to be emitted from the decomposition of material in landfills and from organic wastes from livestock (i.e., cattle, pigs)?
- a) nitrogen
 - b) methane
 - c) chlorofluorocarbons
 - d) ozone
22. Which country contributes the greatest amount of greenhouse gases **per person**?
- a) Canada
 - b) China
 - c) Germany
 - d) India
 - e) United States
23. The current approximate global average proportion of CO₂ in our atmosphere measures in the range of _____parts per million.
- a) 250-300
 - b) 380-400
 - c) 570-610
 - d) I do not know.

24. Which of the following statements **best reflects** the current state of scientific opinion as summarized by the IPCC (Intergovernmental Panel on Climate Change)?
- a) The majority of scientists believe that the current rate of climate change is real and caused by human activity.
 - b) Some scientists believe that the current rate of climate change is real and caused by human activity.
 - c) Scientists do not agree on what is causing climate change.
 - e) Scientists do not believe there has been a significant change in the rate of climate change.
25. Which of the following observed changes are believed to be effects of global climate change?
- a) acidification of the oceans
 - b) animals breeding earlier than normal
 - c) an increase in the number and size of jellyfish
 - d) some coral reefs are dying off
 - e) all of the above
 - f) a and b only
 - g) none of the above
26. Which of the following events **best** describes one of the outcomes of climate change?
- a) a decrease in drought
 - b) an increase in tsunamis
 - c) an increase in average sea levels
 - d) a decrease in ozone depletion
27. The carbon footprint (also known as ecological footprint) of someone in Vietnam is approximately **.76**. What is the approximate carbon footprint for someone living in Canada?
- a) 1.8
 - b) 3.9
 - c) 5.7
 - d) 8.5
 - e) I do not know what a carbon footprint is.
28. What is the approximate size of the Great Pacific garbage patch in the Pacific Ocean?
- a) I have never heard of the Great Pacific garbage patch.
 - b) 10 football fields
 - c) Vancouver Island
 - d) larger than Texas

29. What is the **main** source of electrical energy for BC homes?
- a) coal burning power plants
 - b) solar energy collectors
 - c) hydroelectric dams
 - d) wind turbines/windmills
30. What plastics are **not** accepted into the City of Surrey's residential recycling program?
- a) 1, 2, 3, 6
 - b) 2, 3, 4
 - c) 3, 6, 7
 - d) All plastics #1-7 are accepted.
 - e) I do not know.
31. What is BC's provincial flower?
- a) crocus
 - b) daffodil
 - c) dogwood
 - d) tulip
 - e) wild rose
32. Which of the following animals live in BC? (circle all that apply)
- a) salamander
 - b) river otter
 - c) Bald eagle
 - d) manatee
 - e) Kermode (Spirit) bear
 - f) marmot
33. The Mountain Pine Beetle has caused extensive damage to the forests of the north and interior of BC. Which of the following is a **major factor** in this event?
- a) The population of the beetles' predators has decreased.
 - b) The winter temperatures are no longer cold enough to kill the adults, eggs and larvae.
 - c) The beetles have adapted so that they can resist the defence provided by tree resin.
 - d) The new trees cannot grow large enough to defend themselves.
34. What is the main reason that pandas in China have become an endangered species?
- a) Poachers are killing them for their fur and paws.
 - b) They are being sold illegally as exotic pets and for zoos.
 - c) The deforestation of bamboo forests makes their food supply scarce.
 - d) They are not an endangered species.

35. What North American population has been significantly reduced and threatened due to illegal logging activity and a decrease in its food supply caused by the use of herbicides?
- black bear
 - beaver
 - Monarch butterfly
 - bison



36. The above diagram represents a food web. Which of the following species should be placed in the **position #1** on the Food Web diagram?
- salmon
 - elk
 - grizzly bear
 - algae
37. Which of the following species should be placed in the **position #2** on the Food Web diagram?
- salmon
 - elk
 - grizzly bear
 - algae
38. How well do you feel your high school education has equipped you to understand basic ecological knowledge and environmental problems?
- very adequately
 - somewhat adequately
 - not very adequately
 - not adequately at all

39. How important do you think it is to learn about ecosystems and environmental topics?
- a) very important
 - b) somewhat important
 - c) not very important
 - d) not important at all

This is the end of the survey. Thank you very much for your participation.

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Appendix C: Invitation letter**Invitation and Project Information Letter**

Title of the Research Project: Evaluating Ecoliteracy Among Secondary School Students

Principal Researcher: Lisa Duncan

Thesis Supervisor: Dr. Milt McClaren

As a graduate student from the School of Environment and Sustainability at Royal Roads University, I am currently seeking participants to aid in my thesis research which explores ecoliteracy (environmental understanding).

You have been invited to participate in this survey because you are a Grade 12 student from the Surrey School District. I have been employed in this district since 1998 as a teacher at North Surrey Secondary.

Participation in this study is completely voluntary and anonymous. No personal information will be collected. The information you provide will be summarized, in anonymous format, in the body of the final report. Furthermore, information collected will be used for my thesis. You will have the option to stop the survey at any time. If you do not complete the survey, the data from the incomplete survey will not be used in the research.

You are being asked to answer the questions truthfully to the best of your knowledge, without accessing outside assistance or resources.

If you agree to participate please take home the attached Consent Form to be read and signed both by you and a parent/guardian. If you choose not to participate in this research project your decision not to participate will be treated as confidential.

If you agree to participate, your English 12 or Communications 12 teacher will provide you with the survey and will supervise you during the duration of the survey. The survey should take approximately fifteen to twenty minutes to complete.

If you have any questions or concerns please contact me via email at [Email Address] or my thesis supervisor, Dr. Milt McClaren, at [Email Address]. You can verify my student status at Royal Roads University or seek any information about the study by contacting Dr. Liza Ireland, Acting Program Head, MAEEC program, via email at [Email Address].

I sincerely appreciate that you have taken time out of your busy schedule to assist me in my research and I thank you in advance for your participation.

Sincerely,

Lisa Duncan

Appendix D: Student Consent Form**RESEARCH STUDENT CONSENT FORM**

My name is Lisa Duncan and I am completing my Master of Arts in Environmental Education and Communication at Royal Roads University. I have been a teacher at North Surrey Secondary since 1998. The research project to which this Consent applies is the basis for my thesis.

My credentials with Royal Roads University can be established by emailing my thesis supervisor Dr. Milt McClaren, [Email Address] or the program head Dr. Liza Ireland [Email Address]. Feel free to contact me anytime if you have questions [Email Address].

This document constitutes an agreement with you to take part in my research project. The objective of my research is to evaluate the environmental understanding of Grade 12 students currently enrolled in English 12 or Communications 12 in the Surrey District.

The research will consist of completing an anonymous survey about environmental attitudes, beliefs, experiences and knowledge, which should only take fifteen to twenty minutes to complete. The survey is **not a test and does not count for marks**; participants are simply asked to answer the questions truthfully and to the best of their ability without any outside assistance or resources.

No personal identifying information will be collected through the research project, and no attempt will be made to link answers that are given with the student's identity. At no time will any specific comments be attributed to the student. All documentation will be kept strictly confidential and will be used for purposes of my thesis work. This will involve summarizing and interpreting the survey data in my final thesis report.

Your participation is greatly appreciated. If you do agree to take part, you are free to withdraw from the project at any time with no prejudice or consequence.

By signing this letter, you give consent to participating in this research project and your parent/guardian confirms their agreement for your participation. Please sign two copies and keep one for your own records. **Please ensure a parent or legal guardian also signs both copies of the consent form.** Return one signed copy to your teacher.

Name: (Please Print): _____

Signed: _____

Date: _____

Parent/Guardian Signature: _____

Date: _____

Researcher: Lisa Duncan

Date: March 23rd, 2014

Appendix E: Teacher Consent Form**RESEARCH SPONSOR TEACHER CONSENT FORM**

My name is Lisa Duncan and I am completing my Master of Arts in Environmental Education and Communication at Royal Roads University. I have been a teacher at North Surrey Secondary since 1998. The research project to which this Consent applies is the basis for my thesis.

My credentials with Royal Roads University can be established by emailing my thesis supervisor Dr. Milt McClaren, [Email Address] or the acting program head Dr. Liza Ireland [Email Address]. Feel free to contact me anytime if you have questions [Email Address] or [Email Address].

This document constitutes an **agreement for you to take part as a teacher supervisor** in my research project entitled, Evaluating Ecoliteracy Among Secondary Students. The objective of my research is to evaluate the ecoliteracy (environmental understanding) of Grade 12 students currently enrolled in English 12 or Communications 12.

Your participation consists of having you distribute and collect Consent forms from your English 12 or Communications 12 students (one class unless otherwise discussed). Once collected, please select a convenient time to have your students complete the anonymous survey (during class time) so that they all take it at the same time. You will collect the surveys and place them into a sealed envelope along with the consent forms and I will arrange to collect them. The survey takes approximately fifteen to twenty minutes. The questions relate to ecological and environmental attitudes, beliefs, experiences, and knowledge, some of which are based on the Science 10 curriculum. **The survey is not a test; participants are simply asked to answer the questions truthfully and to the best of their ability without any outside assistance from the supervising teacher or other resources.**

No personal identifying information will be collected through the research project, and no attempt will be made to link answers with the identity of your students. All documentation will be kept strictly confidential and will be used for purposes of my thesis work only. This will involve summarizing and interpreting the survey data in my final thesis report. If requested I can share the results of the survey with you and I would also be willing to provide you with post survey discussion questions/lesson plan ideas that relate to the survey for your class.

Your valuable time and participation are greatly appreciated. If you do agree to take part as a teacher sponsor, you are free to withdraw from the project at any time with no prejudice or consequence.

By signing this letter, you give consent to acting as a teacher sponsor for this research project. Please sign two copies and keep one for your own records. Return one signed copy for me.

Name: (Please Print): _____

Signed: _____

Date: _____

Researcher: Lisa Duncan

Date: March 26th, 2014

Appendix F: Survey Instructions

Ecoliteracy Survey Instructions from Lisa Duncan

Participating School: _____ **Teacher Sponsor:** _____

In this package you will find the following documents:

1. Two copies of the Teacher Consent form. Please read and sign it for me—the other copy is for your records.
2. Two copies (per student) of Invitation Letter/ Student Consent form. Student needs parent/guardian to sign one copy and student keeps a copy.
3. One copy of Ecoliteracy Survey per student.

Instructions:

1. Hand out Student Consent forms ASAP and have students return within a few days.
Only those who return it can take the survey.
2. Decide a convenient day/time when all participating students with consent can take the survey simultaneously in a quiet environment. They should only need ~15-20 minutes to complete.
3. Have students take the survey using dark pen. Please remind them that they are not to write their names on the forms and during the survey they are not to talk or discuss answers with their teacher or other students. They may not use any outside resources (i.e., internet). Students may stop or discontinue the survey at any time.
4. Once completed, please place all consent forms and all completed and unused surveys into the yellow envelope, seal it and store in a secure location. Please email me when you have everything completed so that I can pick up the envelope.

THANK YOU! Email: [Email Address] Cell: [Phone Number]

IF POSSIBLE, PLEASE COMPLETE BY FRIDAY APRIL 11TH

IF YOU NEED MORE TIME JUST LET ME KNOW.

