Environmental Attitudes and Travel Behavior of Youth

by

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BASc., The University of British Columbia, 2007

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF APPLIED SCIENCE
in
The Faculty of Graduate Studies

(Civil Engineering)

THE UNIVERSITY OF BRITISH COLUMBIA
(Vancouver)

October 2012

Abstract

Environmental problems relating to transportation have increased in severity in many cities within Canada. Reduction in emissions generated from the transport sector will require far reaching technological advances as well as behavioral shifts by the population. This study is carried out with a focus on influencing youths to increase the use of sustainable transportation. Studying the attitudes of young people towards the environment is important given they will be the ones affected by environmental issues arising from our current actions and consequently will be the individuals who will ultimately have to come up with resolutions. In preparation to address future transportation issues, it is critical to conduct researches with a focus on children and young people as attitudes toward the environment begin to develop in childhood.

This study surveyed over 1000 students from 11 secondary schools in Richmond, Canada and Vancouver, Canada. The purpose of the survey is to examine the relationship between environmental knowledge, environmental attitudes and travel behavior. Structural equation models (SEMs) were used to quantify environmental attitudes as latent variables, as well as to examine the relationship between environmental knowledge, attitudes and travel behavior while controlling demographic and socioeconomic variables. The results indicate that 1) Students who have better knowledge on environmental issues hold higher levels of pro-environmental attitudes; 2) Students who use active transportation, public transit and school buses to/from school have stronger pro-environmental attitudes than students who travel to/from school by car; 3) Environmental attitude is found to be a mediating variable between environmental knowledge and travel behavior; and 4) Environmental knowledge has a significant impact on the relationship between environmental attitudes and travel behavior.

Based on these findings, it is evident that continual improvement of the environmental education curriculum is needed. It is recommended that the curriculum should not be limited to knowledge-based education on transportation. Rather, it should include activities that will help induce a positive environmental attitude. It was also found that social media and school

courses are major sources of environmental information for the students. Therefore, educational institutes, government, environmental NGOs should continue to leverage these channels to effectively disburse information.

Preface

The thesis research received an approval of the University of British Columbia Behavioural Research Ethics Board (UBC BREB NUMBER H11-00467) on January 6, 2012.

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Acknowledgements

The completion of this thesis marks the end of an exciting and enlightening academic journey. I would like to acknowledge the many people who made contributions along the way. My thanks go first to my supervisor, Dr. Jinhua Zhao, who has consistently supported, guided, challenged, and helped me through all the research projects that I worked on. Dr. Zhao's high expectations and attention to detail encouraged me to give my best throughout this process. I would also like to thank Dr. Brad Flamm for a very thoughtful review of the thesis.

This research would not be possible without the principals and teachers support, as well as the students who spent time in filing the surveys. Special thanks to the research team for survey implementation and data input. I would also like to express my appreciation to the University of British Columbia for giving me the opportunity to complete this Master's program which has been unbelievably effective to me.

My very sincere thanks go to my former colleagues. They have evoked my interests in transportation planning, guided me intellectually, socially and personally during and after my work with them.

Many people supported me personally throughout this journey including my family and friends who showed interest and encouraged me in my academic pursuits. Countless thanks go to my grandmother who always cooks me soup to keep me healthy during my study. Finally, I want to thank my parents who first introduced me to the academic life and encouraged me to always put forward my best.

To my family

1 Introduction

1.1 Motivation

In early 2009, Mayor Gregor Robertson formed the Greenest City Action Team with the goal to make Vancouver the world's Greenest City by 2020. The group of community leaders who hold knowledge and experience across a range of the most pressing environmental issues Vancouver faces researched best practices from leading green cities around the world. Goals and targets have been established that will help Vancouver to accomplish its goal to be the Greenest City. Amongst the goals and best practices, green transportation is an area where the most people can take part in, which includes transit, as well as active transportation like cycling and walking. This is the initiative that motivated this research on environmental attitude and travel behavior.

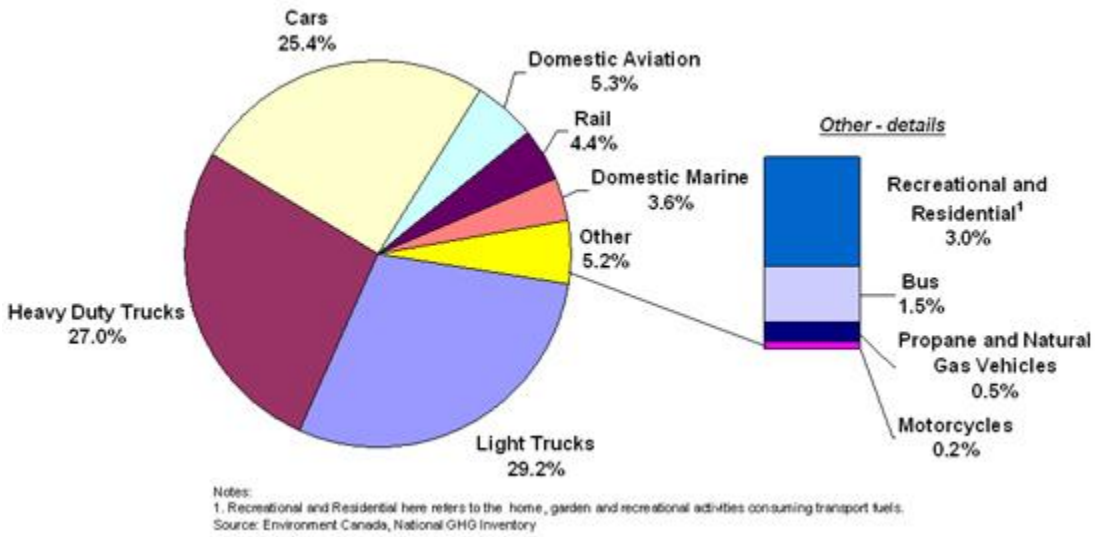
How we move around a city makes a big difference to our quality of life. The air we breathe, the amount of land we need, our physical health and well-being, and the cost of travel are all impacted by our transportation choices. Transportation is also about the places we see and experience on the way to our destinations. To achieve the Green Transportation goal, we will need to transform Vancouver into a city where moving on foot or by bike is safe, convenient, and enjoyable. "Transit should be fast, frequent, reliable, accessible, and comfortable, getting you where you need to go when you need to get there. Streets, public spaces, and neighborhoods should be vibrant places that are alive with people, plants, and activities" (City of Vancouver 2012). Aside from transportation infrastructure improvements, intervention opportunities identification is also important. Understanding where youth go, how they get there, how much time they spend, what they do there and what influences their allocation of time and activities are areas of interest that influence travel behavior.

1.2 Significance

Personal transportation decisions made by Canadians impact the environment through emissions of pollutants, greenhouse gases as well as use of land for roads and streets. According to Environment Canada (2010) , the transportation sector is one of the biggest sources of emissions in Canada, which produced 22 percent (162Mt) of total greenhouse gas

(GHG) emissions (734Mt) in 2008. Of the 162Mt of emissions resulting from transportation sources, 54.6 percent of that amount was emitted by passenger cars and light trucks (Figure 1.1). GHG emissions from private motor vehicles have gone up 35% from 1990 to 2007, almost twice the growth rate of Canada's population (19%) during the same period (Statistics Canada 2010).

Figure 1.1 2008 Canadian Transportation Greenhouse Gas Emissions by Mode



The Government of Canada is making progress towards the target of reducing Canada's total GHG emissions by 17 per cent from 2005 levels by 2020. The Government of Canada recognizes that reducing emissions from the transportation sector can achieve its climate change goals. As a result, tougher regulations for cars and light trucks were introduced to reduce emissions from these vehicles by 25 percent. Environmental professionals argue that while technical improvements can decrease pollution per vehicle, this change alone cannot resolve the problem caused by continuously increasing car production and use (Greening, Greene et al. 2000; Isenhour 2010). Reducing the emissions from the transport sector will require far reaching technological as well as behavioral shifts (Bristow, Pridmore et al. 2004; Anable, Lane et al. 2006; Banister and Hickman 2006).

This study is carried out in light of the idea of influencing youth to increase the use of sustainable transportation at the present and in the future. Sustainable transport here refers to any means of transport with low impact on the environment including but not limited to walking, cycling, transit and carpooling.

Young people are recognized as an important group for the development of a sustainable environment (The United Nations Conference on Environment and Development 1993). Studying young people's attitudes toward the environment is particularly important as they are the ones who will be affected and will have to provide resolutions to the environmental problems arising from our current actions. As attitudes towards the environment begin to develop in childhood, it may be critical to focus on children and young people in order to address transportation issues in the future (Kopnina 2011). Young people develop their attitudes based on what they have learned and experienced through their behavior. These attitudes may sustain themselves into the future and exert impact on behavior as children grow up and become decision makers of their action.

Having a better understanding of the relationship between environmental knowledge, environmental attitudes and travel behavior provide important insights into how educational institutes, the government and environmental NGOs can develop and improve environmental education programs in connection to travel behavior. The ultimate goal of the study of environmental attitudes and young people is to influence students toward sustainable behavior in the future.

1.3 Research Objectives

This research aims to

1) Benchmark environmental knowledge and environmental attitudes among youth
2) Explore the differences between general and transportation-specific environmental knowledge and environmental attitudes
3) Examine the impact of environmental knowledge on environmental attitudes
4) Disentangle the causal direction between environmental attitudes and travel behavior

5) Examine the relationship between environmental knowledge, environmental attitudes and travel behavior
6) Explore the environment educational program and policies in British Columbia

1.4 Research Approach

In an attempt to achieve the stated objectives, the first step is to complete a literature review of models and theories that can be used to examine the linkage between knowledge, attitudes and behavior. After a comprehensive literature review, the analytical framework for this study is developed to test the complex interrelationship among the variables. The survey is then designed and conducted in 11 high schools in the City of Richmond and the City of Vancouver. To conduct analysis of survey results, methods used in behavioral science research have been reviewed. Based on the sample size, structure, and detail of the available data, structural equation modeling is chosen as the appropriate analytical method for this study. The model results are summarized so that recommendations can be developed to improve the environmental education programs in connection to travel behavior.

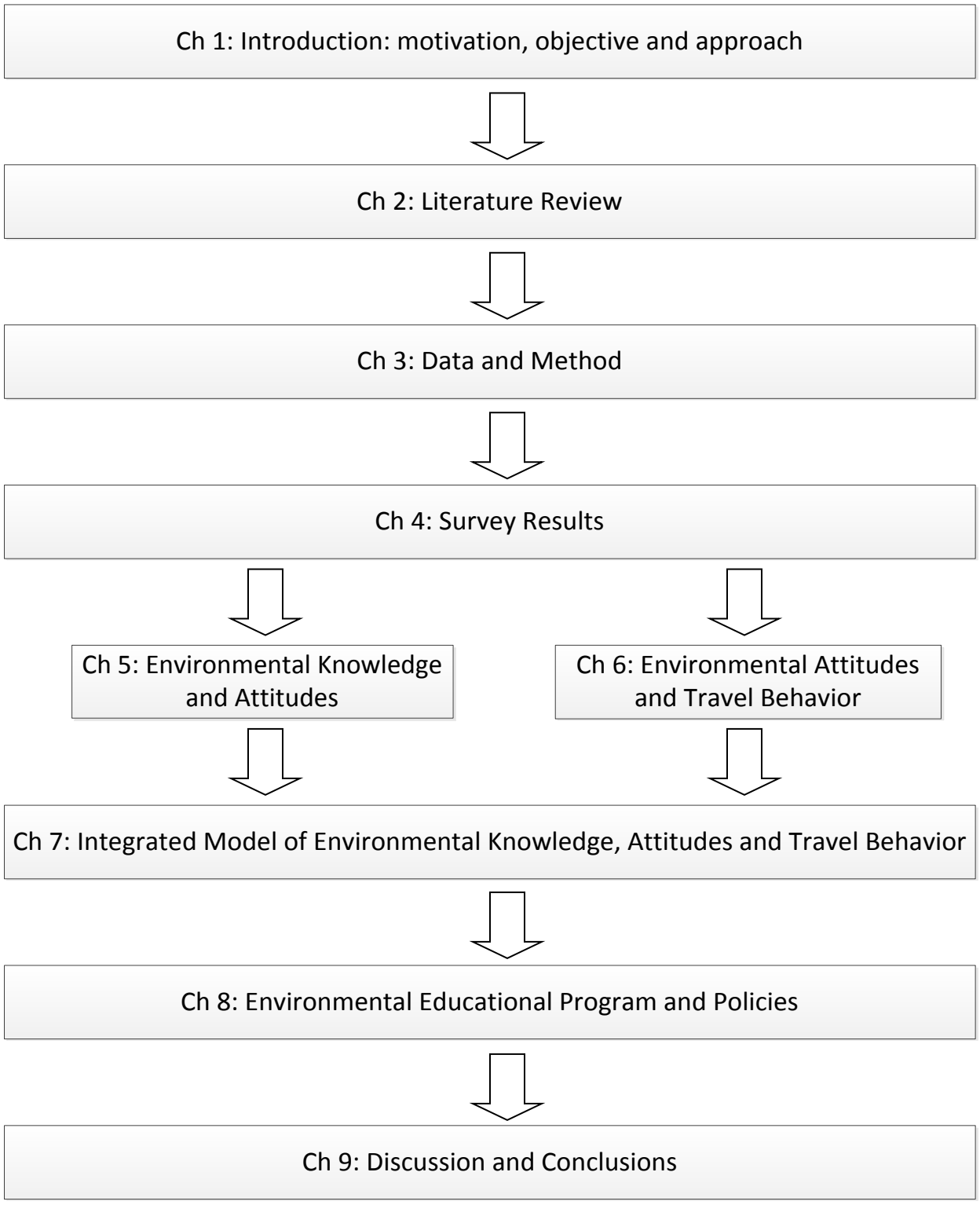
1.5 Thesis Organization

The thesis is organized as follows (see Figure 1.2):

Chapter 1 provides an introduction to this thesis. Chapter 2 explores previous research on knowledge, attitudes and behavior linkages. It also describes the methods used to test the relationships between these factors. Finally, it introduces the analytical framework, followed by research questions and study hypotheses. Chapter 3 explains the study methodology, sampling method, survey design and distribution method used to collect data and models used to conduct the analysis. It also describes the procedures used to screen the data set and remove inconsistent records. After, Chapter 4 provides the descriptive statistics of the sample population, followed by the analysis on three key aspects of this research: environmental knowledge, environmental attitudes and travel behavior. Chapter 5 presents a model examining the impact of environmental knowledge and environmental attitudes. Chapter 6 is devoted to the findings of the structural equation model developed specifically to explore the

directions of causality between attitudes and behavior. Chapter 7 presents a series of structural equation models to examine the relationship between environmental knowledge, attitudes and travel behavior. Chapter 8 presents a discussion on environmental educational programs and policies in British Columbia. Chapter 9 summarizes the findings, discusses policy implications and suggests directions for future research.

Figure 1.2 Thesis Organization



2 Literature Review

This chapter first introduces the three key concept of this research: environmental knowledge, environmental attitudes and travel behavior. Then it provides an overview of the frameworks and theories used to examine the link between knowledge, attitudes and behavior. In particular, it explores the different approaches to analyze the causality between attitudes and behavior. Since no previous studies directly addressed the relationships between environmental knowledge, environmental attitudes and travel behavior on youth, this chapter reviews studies examining the relationships between environmental knowledge, attitudes and behavior of youth, followed by studies on environmental knowledge, attitudes and travel behavior of adults. The analytical framework for this study is revealed at the end of this section.

2.1 The Concept of Environmental Knowledge, Attitudes and Travel Behavior

2.1.1 Environmental Knowledge

Environmental knowledge reflects people's understanding and ability to identify environmental issues. It has been an interdisciplinary subject drawing relevant knowledge from natural and social sciences as well as humanities. At times, it is also used to deal with moral decisions about values and powers (Hausbeck, Milbrath et al. 1992)

Maloney and Ward (1973) compared members of a conservation group, a group of college students, and a non-randomly selected group of adults with no college experience from California. They found that environmental knowledge was associated with conservation group membership and education. Arcury et al. (1986) examined the relationship between environmental worldview, measured with the New Environmental Paradigm (Liere and Dunlap 1980), and general environmental knowledge. Worldview, income, education and gender were found to have positive influence on knowledge. The NEP scale is designed by Dunlap and Van Liere (1978) to measure the extent to which people would accept the ideas of the New Environmental Paradigm which will be explained in detail in the next section.

Blum (1987) found that high school students in four countries possessed low levels of environmental knowledge. He compared five surveys conducted in the United States, Australia, England, and Israel that assessed environmental knowledge and beliefs of 9th grade and 10th grade students. Results indicated that the students' beliefs in environmental causes were generally stronger than their factual and conceptual knowledge. He concluded that students' level of factual and conceptual knowledge was rather low and that schools have much to do to improve the knowledge base of all students. Hausbeck et al. (1992) surveyed 3,200 students from a sample of 30 secondary schools in the State of New York to assess levels of environmental knowledge, environmental awareness, and environmental concern. They found that environmental knowledge was positively correlated with age, family, income, gender, and exposure to mass media and personal sources outside of school. They also found that students scored rather low on knowledge questions; however, the students reported that they would like additional environmental education to be offered in school. The authors concluded with policy suggestions for improved environmental education at the secondary school level in New York State and the United States at large.

Kuhlemeier (1999) examined the environmental knowledge of more than 9000 students from 206 secondary schools in the Netherlands. Results show large groups of students lacked knowledge on environmental topics such as energy usage; soil, air, and water pollution; recycling; agricultural activities; tourism; transportation; and recreation. It was found that teachers seldom discussed with students the causes of environmental problems or potential solutions due to a lack of suitable teaching materials. As a result, the environmental knowledge that students already possessed was likely to determine by topicality and to be fragmentary, incorrect, or both (Hausbeck, Milbrath et al. 1992; Munson 1994)

Despite the importance of environmental knowledge in environmental studies, there is a lack of consistency in measurement. Some measured the environmental knowledge on global issues including greenhouse effect and acid deposition while others measured environmental

knowledge on local issues, such as energy and water supply. There is a great variation in method of inquiry, types of questions, and scope of environmental issues.
In most of these studies, environmental knowledge was measured by asking participants to respond to multiple-choice or true-false questions (Chan 1996; Gambro and Switzky 1996; Bradley, Waliczek et al. 1999; Kuhlemeier, Bergh et al. 1999; He, Huo et al. 2004; He, Hong et al. 2011). Other types of measurement of environmental knowledge employed include the use of a self-reported assessment by asking respondents to estimate their level of knowledge on specific topics (Arcury, Johnson et al. 1986). In some other studies, respondents' environmental knowledge was assessed based on responses to open-ended questions on selected global or local environmental issues.

2.1.2 Environmental Attitudes

Environmental attitudes reflect people's mental-psychological projection on environmental issues. It could be considered as an enduring positive or negative feeling towards a particular aspect of an environment object or issue. Environmental attitude studies have served an important psychological function in that they have helped people make decisions involving the use and care of the physical environment, such as a decision to put litter into waste recycling receptacles, to join environmental organizations and to use public transportation to school or work (1996).

Environmental attitudes are often discussed in the form of environmental concerns. Grganon-Thompson and Barton (1994) described environmental concern as motivated either by a true care for the nature, or by a care for nature as a human resource. Early research showed that environmental concern would determine actions promoting a sustainable environment (Arbuthnot 1977; Kallgren and Wood 1986; Stern and Oskamp 1987). Another factor of environmental attitude is the perceived threat of environmental degradation. However, previous studies suggest that environmental attitudes may also be jeopardized by perceptions of the quality of the local environment (Liere and Dunlap 1980; Blake, Guppy et al. 1997).

The most common approach to environmental attitude measurement has been the use of self-report scales on a number of local and global ecological issues and the scales have been concerned with interaction between human activities and natural resources. Maloney and Ward (1973) developed a scale for the measurement of ecological attitudes that comprise of three subscales: verbal commitment, which measures what a person states he is willing to do in reference to pollution-environment issues; actual commitment, which measures what a personal actually does in reference to pollution environmental issues; and affection, which measures the degree of emotionality related to such issues.

Weigel and Newman (1976) developed a general attitude measure to assess people's attitudes towards the environment, namely the environmental concern scale. It considered 16 items that measured respondents' attitudes towards a variety of ecological issues, such as pollution, conservation of natural resources and wildlife preservation. The environmental concern scale was first tested with a random sample of 141 respondents in 1970 and achieved adequate internal consistency, with a Cronbach alpha coefficient of 0.88. Shanahan (1993) updated the environmental concern scale to measure more contemporary issues. The updated version consisted of 17 items under four subscales including environmental optimism, the relative importance of environmental issues compared to economic and technological progress, attitudes toward specific environmental issues and personal impacts.

Dunlap and Van Liere (1978) designed the New Environmental Paradigm (NEP) scale. It consisted of 12 items that measured respondents' attitudes towards ecological issues on man's influence on the balance of nature, limits to growth on the human population size and whether humans should have rightful dominion over nature. The NEP scale was tested on a sample of 806 respondents and another sample of 407 members of an environmental organization. The alpha coefficients for the general public and environmental group samples were 0.81 and 0.76, respectively, suggesting that the NEP scale was internally consistent. Dunlap et al. (2000) revised the NEP scale to improve upon the original one as it provides more comprehensive coverage of key facets of an ecological worldview, avoids the unfortunate lack of balance in item direction of the original scale, and removes the outmoded, sexist terminology in some of

the original scale's items. The revised NEP scale has slightly more internal consistency than did the original version (Cronbach's alpha of 0.83 vs 0.81). Many studies directly used the developed scales, while others adapted the scales to better suit their local area condition, sample group and survey implementation (Chan 1996; Ivy, Road et al. 1998; Worsley and Skrzypiec 1998; Kuhlemeier, Bergh et al. 1999; Kilbourne, Beckmann et al. 2002).

2.1.3 Travel Behavior

Travel behavior is the study of how people travel across distances and the mode at which they travel by. The questions studied can be of a broad range. Information on how many trips are made, origin and destination, mode choice, frequency and pattern, and intentions are usually captured via travel survey (Line, Chatterjee et al. 2010). In particular, behavior intention is an area of interest as it relates to environmental knowledge and environmental attitudes.

Intention is an important influence on actual behavior. If an individual does not intend to behave in a given way, it is unlikely they will carry out the behavior, even if they have the opportunity to do so (Line, Chatterjee et al. 2010). People are more likely to express support for environmental behavior than they are to fulfill their promises. It has been suggested that verbal commitment to act more likely reflects the probable future than it does current behavior (He, Hong et al. 2011). In addition, responses are subject to the researcher's choice of words when defining the questions. It is important to recognize the need to examine the subjective, individualistic nature of such influences.

Previous research has shown that the travel behavior intentions of young people between the ages of 11 and 18 are dominated by the desire to drive and/or own a car in the future (Turner and Pilling 1999; Storey and Brannen 2000; Derek Halden Consultancy 2003). At the age of 17, young people move from being predominantly car passengers to being car drivers. While little research has been carried out to explore what determines young people's intentions in this context, it can be assumed that not all will have the intention to drive when given the opportunity to do so. At the same time, other young people may have the intention to drive

but no opportunity to do so, while others may have to create the opportunity to drive (by obtaining a job to finance driving lessons for example) in order to fulfill their intention.

The study by Line et al (2010) found that young people have a strong desire to continue driving or to learn to drive in the future and expressed an unwillingness to change their travel behavior intentions in light of climate change. It was found that values act as the underlying influence on their travel behavior intentions. Young people value identity, image and social recognition in particular. It is also important to note that, although young people recognized that using alternative fuel vehicles or modes other than the car may be more 'environmentally friendly', they appear to place little value on 'the environment'. This suggests while pro-environmental values may exist, other values of higher perceived importance may take precedence and influence the behavior intention in the opposite direction. A Scottish research study by Derek Halden Consultancy (2003) found that peer pressure was one of the most significant factors affecting young people's travel mode choices. For example, if cycling is not regarded as a socially-acceptable form of transport amongst a certain age group then it will be very hard to encourage more people to cycle.

2.2 Psychological Models Linking Knowledge, Attitudes and Behavior

There has been considerable work done in trying to understand behavior by looking at the influences and processes involved in individuals' decision-making. They differ according to the degree to which they incorporate internal and external influences including wider social processes and opportunity to act (Anable, Lane et al. 2006).

2.2.1 The Linear Model

The early models examining the connection between knowledge and action focused on humans as being rational. These frameworks utilized a linear progression, in which environmental knowledge led to environmental attitudes, which in turn were thought to lead to pro-environmental behavior (Kollmuss and Agyeman 2002). The early linear frameworks have been termed 'deficit' models of public understanding and action (Figure 2.1). The assumption is that if people knew and understood more about connections between their own behavior and

environmental threats, they would act in a more sustainable way, thus responding more rationally to environmental risks.

Figure 2.1 Linear 'deficit' Model of Pro-Environmental Behavior

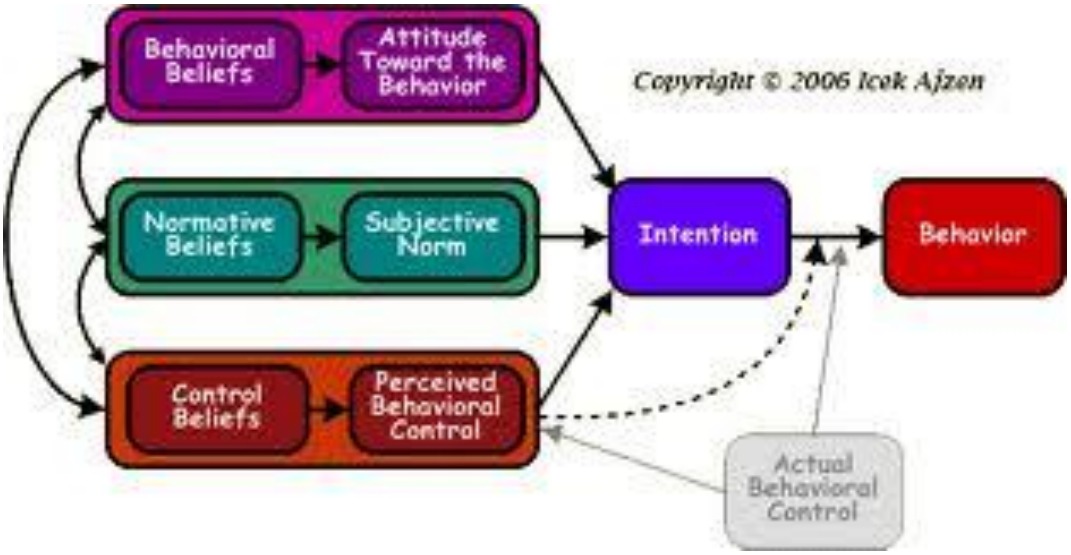
(Source: Kollmuss and Agyeman 2002)

This approach has been used in many behavior change programs, including large scale awareness-raising campaigns such as "Are You Doing Your Bit?" launched in 1998 in England and Wales (Department of the Environment Transport and the Regions 1999). However, this approach is not without shortcomings. Hounsham (2006), after reviewing the literature and consultation with experts on how to motivate green behavior, concluded that change from the provision of information alone is very minor. He stated that "most of the lifestyle decisions we seek to influence are not determined mainly by rational consideration of the facts, but by emotions, habits, personal preferences, fashions, social norms, personal morals and values, peer pressure and other intangibles". Anable et al. (2006) asserted that a large proportion of studies assume a linear link between attitudes and behavior without adequate consideration and measurement of other psychological and contextual factors that may shape behavior and the dynamic interrelationships between them.

2.2.2 Theory of Planned Behavior

Ajzen's (1991) Theory of Planned Behavior is the most common and influential theory used to understand behavior by examining beliefs, values, concerns, and attitudes in the social, environmental and health psychology fields. The theory predicts that attitudes do not determine behavior directly; rather, Ajzen suggested that attitudes toward a given behavior, subjective norms about that behavior, and perceived level of control over the behavior all contribute to behavioral intentions. Behavioral intentions combined with an individual's perception of control produce the actual behavior (Figure 2.2).

Figure 2.2 Icek Ajzen's Theory of Planned Behavior



Many studies have used the theory of planned behavior to predict mode choice. These studies have generally concluded that the choice of travel mode is largely a reasoned decision related particularly to attitudes and perceived barriers to behavior (Bamberg and Schmidt 1998; Forward 1998). However, other studies suggest that much of people's daily travel mode choices are habitual and not always preceded by the deliberation of alternatives. The addition of habit measure will improve the predictive capability of attitude-behavior studies (Lanken, Aarts et al. 1994; Gärling 1998; Bamberg, Ajzen et al. 2003).

Knowledge is another important variable to the modification of the theory of planned behavior. Beliefs are strongly influenced by a person's values and are dependent to some degree on knowledge. This knowledge may also determine which beliefs are salient and establish the value of the beliefs. While psychologists often consider knowledge a necessary precursor to attitudes, it is not included in Ajzen's original model. Kaiser et al. (1999) have made it an integral part of their adapted theory of planned behavior, and stated that attitudes include not just the evaluation of a certain outcome but also the estimation of the likelihood of the outcome, with factual knowledge being a necessary pre-condition for attitude. This provides the theoretical grounding for the use of a conceptual model that combines knowledge, attitudes and behavior in a single framework.

2.3 The Casual Link between Attitudes and Behavior

Both the linear model and the theory of planned behavior assume that attitudes influence behavior directly or through behavioral intentions. However, there are competing hypotheses regarding the relationship between attitudes and behavior (Tardiff 1977). Attitudes are formed through experience as a result of behavior, while attitudes prompt certain types of behavior (Kitamura, Mokhtarian et al. 1997) . Many studies have found mutual causality between attitudes and behavior (Tardiff 1977; Dobson, Dunbar et al. 1978; Golob, Horowitz et al. 1979; Tischer and Phillips 1979; Reibstein, Lovelock et al. 1980; Lyon 1984; Pendyala 1998; Handy, Cao et al. 2005).

Golob (2001) tested a series of joint models of attitude and behavior to explain how both mode choice and attitudes regarding tolled high-occupancy vehicle lanes in San Diego differ across the population. The sample of approximately 1,500 individuals was divided into three groups: one-third ExpressPass subscribers, former subscribers, and persons on the waiting list; one-third other I-15 commuters, and one-third commuters in another freeway corridor in the San Diego Area. None of the models tested found any significant effects of attitude on choice; all casual links were from behavior to attitudes. Tardiff (1977) came to similar findings that the effect of attitudes on behavior to be weaker than that of behavior on attitudes. He further hypothesized that if attitudes really do cause behavior, the policy emphasis might be on a marketing campaign to change attitudes. However, if the attitudes were merely a response to the behavior, a marketing campaign would have little lasting effect if the conditions of the transportation mode in question were not conducive to a favorable attitude. In this case, an emphasis on physical modal quality would appear to be a more fruitful policy.

There are several ways of assessing if attitudes cause behavior or vice versa: experimental designs, instrumental variable method and granger causality test.

2.3.1 Experimental Designs

Causal relationships are most validly established through experimental designs, in which individuals are randomized to treatment and control groups. This addresses non-spuriousness

and behavior is measured for both groups before and after the treatment of interest (Singleton and Straits 1999). It is assumed that the experimental and control group are equivalent on all important dimensions and that there are no systematic differences between the two groups. The experimental group receives the influence of the independent variable (treatment) in addition to the shared conditions of the two groups. All other conditions are under control to assure changes (if any) are observed in the values of the dependent variable. By holding all other variables constant, a controlled experimental design can help determine if there is a difference in attitude from the introduction of a built environment versus no change in a built environment.

2.3.2 Instrumental Variable

When controlled experiments are not available, instrumental variable can be used to estimate causal relationships. The method of instrumental variables can be used when standard regression estimates of the relation of interest are biased due to reverse causality, selection bias, measurement error, or the presence of unmeasured confounding effects. A third variable, also known as an instrumental variable can be introduced to estimate the causal relationship by extracting variation in the variable of interest. The instrument correlates with the endogenous explanatory variable where it can be used to validate causality exists in the expected direction. In the example of causality between attitude and behavior related to transportation, if a variable can be identified to only affect behavior, then the correlation between the introduced variable and attitude is evidence that behavior is causal to attitude, assuming there is no reverse causality. It should also be noted that in most transportation situations, the structure of relationships among variables is not as simple as having a three variable model, namely attitude, behavior and one antecedent variable. A more realistic approach might be to include a set of antecedent variables as opposed to only one antecedent variable. Tradiff (1977) estimated various models in which attitudes and behavior are jointly dependent on a third set of antecedent variables, e.g. personal and situational descriptors. He suggested that if attitudes and behavior are jointly determined by antecedent variables and only correlated spuriously, a proper policy to change behavior would emphasize changes in the antecedent variables.

2.3.3 Granger Causality Test

Another method is the Granger causality test, which is a statistical hypothesis test for determining whether one time series is useful in forecasting another. A time series X is said to Granger-cause Y if it can be shown, usually through a series of t-tests and F-tests on lagged values of X, that those X values provide statistically significant information about future values of Y. Vector autoregression (VAR) in particular is a statistical model used to capture the linear interdependencies amount multiple time series. All the variables in a VAR are treated symmetrically; each variable has an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. "One approach to the causality question is to examine changes in attitudes and behavior and to inspect the time sequence. A study that monitors attitudes at one time and behavior at a second can be used to assess the impact of antecedent attitudes on subsequent behavior" (Reibstein, Lovelock et al. 1980). For example, Assael and Day (1968) discovered that aggregate brand attitude change tended to lead to changes in brand sales over time. In application related to transportation, the hypothesis testing can be run against attitude and behavior individually in attempts to find out the causality relationship.

2.4 Research on Environmental Knowledge, Attitudes and Behavior of Youth

A key debate in the environmental education research literature revolves around the relationship between environmental knowledge, attitudes and behavior. In order to have positive environmental attitudes, one would expect that an individual must first have the relevant knowledge to hold particular attitudes (Arcury 1990).

Ramsey and Rickson (1976) tested the relationship between environmental knowledge and attitudes among students at three high schools in Wisconsin and found increased knowledge leads to increased awareness of environmental issues. Bradley et al. (1999) came to a similar finding after assessing 475 Texas high school students' environmental knowledge and attitudes before and after exposure to a 10-day environmental science course. The results indicated a significant increase in both knowledge and attitudes of students who took the course. A

significant relationship was found between pretest knowledge scores and pretest attitudes scores and between posttest knowledge scores and posttest attitudes scores. Similarly, Mangas and Martinez (1997) conducted an analysis on environmental concepts and attitudes among 56 biology degree students enrolled in an elective environmental education course at the University of Alicante in Spain. The students' environmental knowledge increased at the end of the course and was accompanied by an increase in environmental attitudes.
Tikka et al. (2000) investigated the effect of completing various science courses on the environmental attitudes of 464 students in Central Finland. The results suggested that students who completed biology courses exhibited more positive attitudes towards environmental issues than did students who enrolled in courses related to technology and economics. Makki et al. (2003) assessed 660 secondary school students in the Greater Beirut area also found that environmental knowledge was significantly related to environmental attitudes.

While most studies reported that youth who have more knowledge about the environment hold pro-environmental attitudes (Ramsey and Rickson 1976; Jaus 1982; Mangas, Martinez et al. 1997; Bradley, Waliczek et al. 1999; Makki, Abd-El-Khalick et al. 2003), environmental knowledge does not seem to promote environmental behavior (Kuhlemeier, Bergh et al. 1999; Negev, Sagy et al. 2008; He, Hong et al. 2011)

Negev et al. (2008) studied 1591 6^{th} grade students and 1530 12^{th} grade students in Israel and found significant correlation between environmental knowledge and attitudes, and between environmental attitudes and behavior, but insignificant correlation between environmental knowledge and behavior. Kuhemeier et al. (1999), on the other hand, after studying a nationwide sample of more than 9,000 students from 206 secondary schools in Netherlands, found the relation between environmental knowledge and attitudes and between environmental knowledge and behavior to be weak, but substantial relation between environmental attitudes and behavior. He et al. (2011) found insignificant relationships between environmental knowledge, attitudes and behavior after studying college students 16 to 20 years old in the City of Shanghai and Gansu Province, China. Meinhold and Malkus (2005) studied 848 students between 14 and 18 years old on the West coast of the United States

(Seattle, Portland, Los Angeles) and found that environmental knowledge was a significant moderator for the relationship between environmental attitudes and environmental behaviors.

2.5 Previous Research on Environmental Knowledge, Attitudes and Travel Behavior

Few studies have examined the relationships between environmental attitudes and travel behavior (Kitamura, Mokhtarian et al. 1997; Golob and Hensher 1998; Kaiser, Wölfing et al. 1999; Choo and Mokhtarian 2002; Handy, Cao et al. 2005), fewer have included measures of both environmental attitudes and environmental knowledge (Nilsson and Küller 2000; Walton, Thomas et al. 2004; Flamm 2009). Walton et al. (2004) addressed the relationships between environmental concern, environmental knowledge, and travel mode choice by distributing a survey to 566 commuters in New Zealand. Environmental knowledge and attitudes were found to have insignificant impact on travel mode choice. Nilsson and Küller (2000) studied the environmental knowledge, environmental attitudes, and travel behavior of samples of citizens and public officials in the town of Lund. Using information from 422 respondents, they measured travel behavior by annual driving distance, frequency of trips, choice of travel mode, and level of acceptance of potential traffic restrictions. The study found that environmental attitudes were more potent than factual knowledge in promoting pro-environmental travel behavior. Nevertheless, Nilsson and Küller (2000) argue that "despite the weak link between factual knowledge and pro-environmental behavior, knowledge must be an operand in establishing environmental concern and should not be neglected".

Flamm (2009) assessed the effects of environmental knowledge and environmental attitudes on the number and types of vehicles owned per household, annual vehicle miles traveled and fuel consumption in the Sacramento, California metropolitan region. The results found that environmental knowledge and attitudes are strongly related: respondents who indicate that protecting the natural environmental is important to them know more about the environmental impacts of vehicle ownership and use. The households of respondents who own more fuel-efficient vehicles know more about the environmental impacts of vehicle ownership

and use. However, environmental knowledge is not statistically significant in relation to the number of vehicles owned, miles driven, and fuel consumption. Overall, pro-environmental attitudes and environmental knowledge increase, number of vehicles owned, miles driven, and fuel consumption decreases. Other than the multiple regression analysis, Flamm (2009) also developed structural equation model to test the bi-directional relationships among environmental knowledge, environmental attitudes and vehicle ownership and use. The result suggests that knowledge and attitudes have a far stronger impact on behavior than behavior does on knowledge and attitudes.

2.6 Mediating, Moderating and Confounding Effect

A common approach of identifying the observed relationship between an independent variable and dependent variable is to hypothesize a direct relationship between the two; an alternative method is via a mediational model. The mediational model hypothesizes that the independent variable causes the mediator variable, which in turn causes the dependent variable (Baron and Kenny 1986). Full mediation occurs when the inclusion of the mediation variable fully accounts for the observed relationship between the independent variable and dependent variable. Partial mediation implies that aside from a significant relationship between the mediator and the dependent variable, there are also some direct relationship between the independent and dependent variable.

Moderators in statistics and regression analysis are variables that can make the relationship between two variables either stronger or weaker; it further characterizes interactions in regression by affecting the direction and/or strength of the relationship between two variables (Cohen, Cohen et al. 2003). Mediation and moderation can co-exist in the form of moderated mediation or mediated moderation. In moderated mediation, mediation is first established, and then factors that affect the magnitude of the treatment effect are investigated. (Muller, Judd et al. 2005)

Confounders are variables that may have a causal impact on both the independent variable and dependent variable. They include common sources of measurement error (as discussed above)

as well as other influences shared by both the independent and dependent variables. Ignoring a confounding variable may bias empirical estimates of the causal effect of the independent variable (Pearl 1998).

2.7 Analytical Framework

This study investigates the relationship between environmental knowledge, attitudes and travel behavior of youth. Since previous studies suggested that the relationship between attitudes and behavior could be bi-directional, this study proposes three model structures to test the complex interrelationship among the variables. In particular, this study distinguishes transportation-specific environmental knowledge and attitudes from general environmental knowledge and attitudes.

Model 1) Examine the impact of environmental knowledge on environmental attitudes.

Model 2) Disentangle the causal direction between environmental attitudes and travel behavior.

Model 3) Examine the relationship between environmental knowledge, environmental attitudes and travel behavior.

3 Data and Method

This chapter first describes the study area, survey design and survey distribution used to collect data. Then it explains how the analysis was conducted, the steps used to screen the data set and remove inconsistent records. Finally, it discusses the methods used to test the validity and reliability of the data, the modeling methodologies used to analyze the relationship between environmental knowledge, environmental attitudes and travel behavior.

3.1 Survey Design and Implementation

3.1.1 Study Area

Two municipalities of Greater Vancouver, the City of Vancouver and the City of Richmond, are chosen as the focus of this research study. In 2006, Greater Vancouver had a population of 2,116,581 living in 870,992 dwellings. It has a land area of 2,877.36 km^2 and a population density of 735.6 per km^2. The demographic and transportation statistics for Greater Vancouver, City of Vancouver and City of Richmond are presented in Table 3.1. The combination of the two cities represents the demographic and transportation statistics for the Greater Vancouver region well, suggesting the survey results collected from the two cities can be generalized for the overall region.

With only four percent of Greater Vancouver's land, the City of Vancouver has over a quarter of the population and over a third of the jobs in the region. The City of Vancouver is renowned for its innovative programs in the areas of sustainability, accessibility and inclusivity. While Vancouver is recognized as one of the world's most livable cities with one of the smallest carbon footprints of major cities in North America, the City of Vancouver had a vision to become a leader in initiating a green movement worldwide. In February 2009, the city launched the Greenest City initiative with a goal to become the greenest city in the world by 2020. The Greenest City 2020 Action Plan was developed and announced in July 2011, consisting of a list of goals, strategies and action items to fulfill the green initiative. The area of interest relating to this research paper in particular is Green Transportation. The strategies in this area include land use, walking and cycling, transit, demand management, low carbon

vehicles, and goods movement. All of which aligns with the topic of environmental attitudes and travel behavior. This well-rounded approach has attracted the participation of group of independent experts representing knowledge and interest across a range of the most pressing environmental issues the City of Vancouver faces.

The City of Richmond, located to the south of the City of Vancouver, represents approximately 10% of the population and jobs in the region. It is a unique island city, located in close proximity to downtown Vancouver and the U.S. border. It is connected to neighboring lower mainland cities by a series of bridges and a tunnel. The City of Richmond offers a number of comprehensive services designed to ensure a clean, livable and sustainable community for current and future generations. One project is the City's Energy Management Program. The City of Richmond has been improving its corporate energy use for over 15 years, resulting in reduced greenhouse gas emissions and contribution to climate change (over 1,800,000 kg of CO_2/year in reduced emissions).

Richmond has gone through significant improvements in its transportation system. Prior to the 2010 Winter Olympics hosted in Vancouver and construction of the Canada Line, which connects the YVR airport and downtown Vancouver, transit ridership in Richmond was merely 12% in 2006. Transit ridership of the Canada Line and was forecasted to see 100,000 boardings per day by 2013. On Aug. 6, 2010, TransLink released figures that show average daily ridership almost reached 100,000 in July. In February 2011, ridership reached 110,000 per day, exceeding the original ridership forecast well in advance. Carrying this many passengers eliminates approximately 14,000 tonnes of greenhouse gas emissions annually. The ridership increases were fueled by buses feeding the Canada Line and transit demand created by City of Richmond's policy of increasing population density in its city centre.

Table 3.1 Demographic and Transportation Statistics for the Greater Vancouver, City of Vancouver and City of Richmond

	2006		
	Greater Vancouver	City of Vancouver	City of Richmond
Population and Households			
Population	2313328[1]	603502[1]	190473[1]
Average Household Size	2.6	2.2	2.8
Average number of cars per household	1.28	1.04	1.74
Age Groups			
19 and under	22.8%	17.9%	22.4%
20-39	28.5%	34.5%	26.5%
40-64	35.8%	34.5%	38.4%
65 and over	12.8%	13.1%	12.7%
Labour force			
Employed labour force	1104760	310640	87180
Unemployment rate	5.6%	6.0%	4%
Household Income			
Median Income	$55,231	$47,299	$53,489
Average Income	$73,258	$68,271	$67,440
Dwelling			
Owned	40.4%	48.1%	76.3%
Rented	59.6%	51.9%	23.7%
Single-detached house	10.4%	19.1%	41.1%
Semi-detached house	1.2%	1.5%	3.0%
Row house	14.7%	3.2%	19.1%
Apartment	73.4%	76.1%	36.3%
Mode of travel to work			
Car, truck, van as driver	67.3%	51.5%	73.0%
Car, truck, van as passenger	7.1%	6.1%	9.0%
Public transit	16.5%	25.1%	12.0%
Walk	6.3%	12.2%	4.0%
Bicycle	1.7%	3.7%	1.0%
Other method	1.1%	1.3%	1.0%

[1] Data in 2011

3.1.2 Survey Implementation

Research applications were submitted to the Richmond School Board (RSB) and Vancouver School Board (VSB) in May 2011 and August 2011, respectively. The application included the study description, survey questionnaire, conditional approval from the University of British Columbia Behavioral Research Ethics Board and a consent form for parents and assent form for students. (Appendix A). The RSB Research Committee approved the application in April, 2011, while The VSB Research Committee approved the application in January, 2012. It took a much longer time for the VSB Research Committee to approve this research due to teacher's job action. Starting in September, 2011, teachers were in a legal strike which restricts their ability to participate in administrative duties and other non-instructional activities. As a result, the survey implementation methods had to be revised to provide an alternative so that surveys can be conducted with or without teachers' assistance. Below are the implementation methods that were available and were customized according to individual school's need. A complete and a short version of the questionnaire were developed depending on the implementation methods. The short version of the questionnaire was developed so that surveys can be conducted without teachers' assistance.

1) In-Class survey

   Our research team prepared and delivered the questionnaires to the schools. The team and/or the partner teachers gave a brief introduction of the project to the students, and students had dedicated 30 minutes during class time to complete the long version of the questionnaire. This enabled the students to give their full attention to the questionnaire. The team and/or the partner teachers were available to facilitate the implementation of the survey and to provide clarification if students had questions.

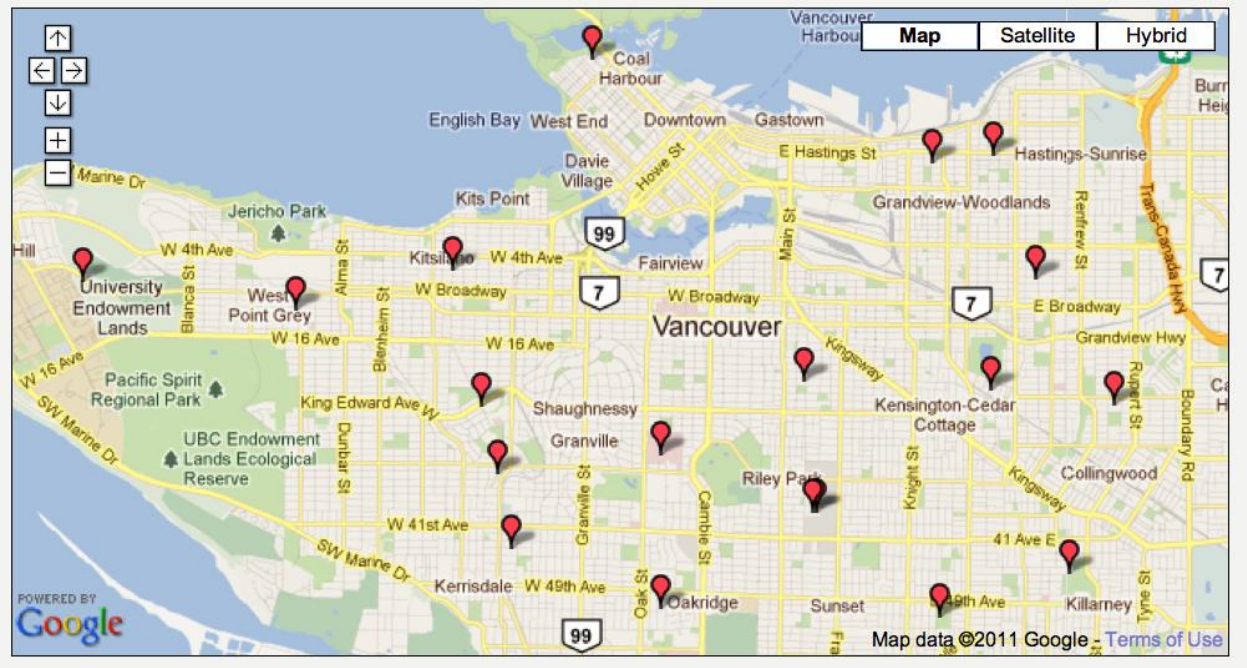
2) Lunch Time Survey

   The research team prepared and delivered the questionnaires to the schools. Booths were set up in the cafeteria or anywhere in the school that could attract the students' attention during lunch time. The research was explained to the students and they were

invited to participate. This short version of the questionnaire took the students 10 minutes to complete.

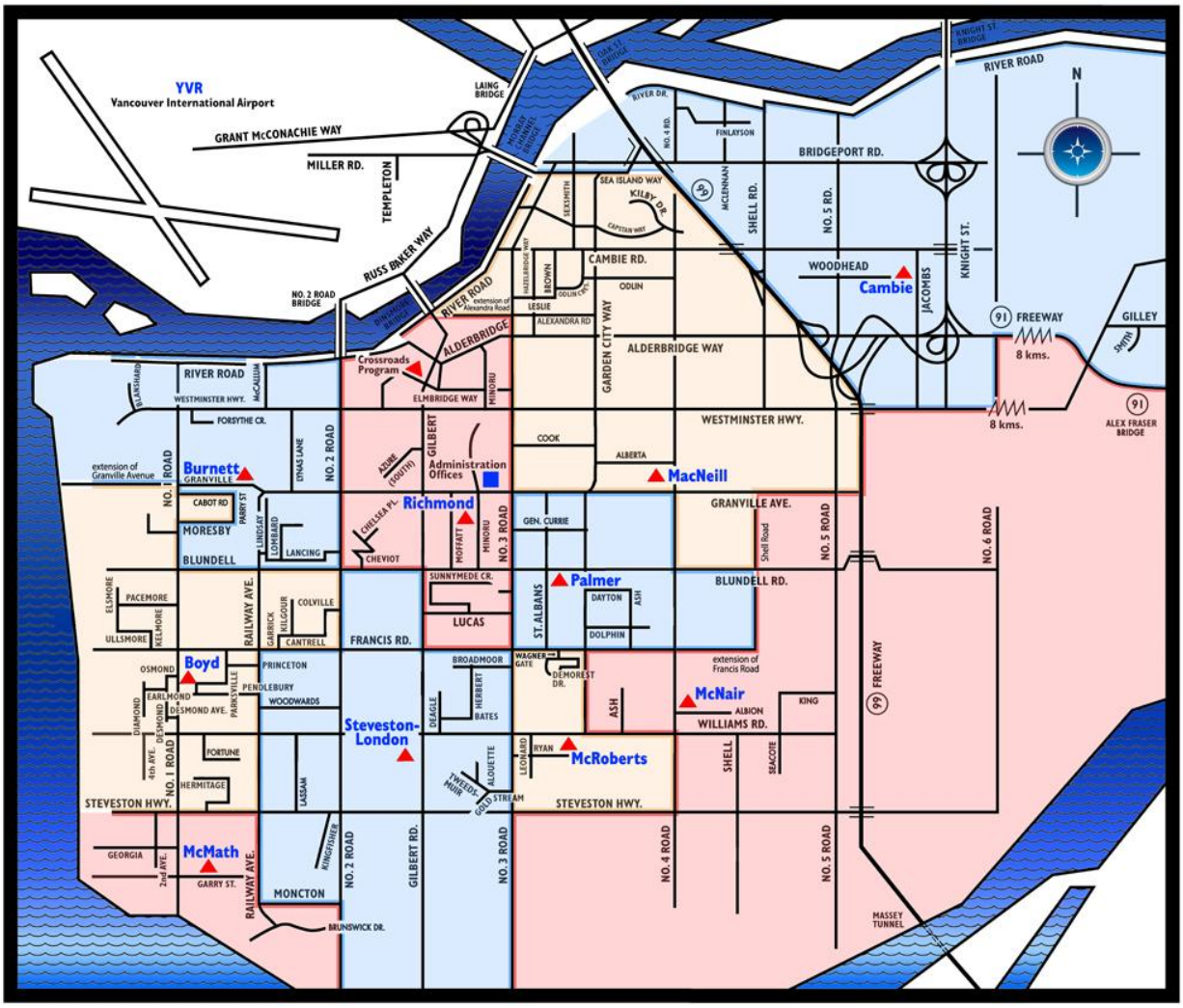
As soon as approval was received from the school board to carry out this research, all 18 secondary schools in the City of Vancouver and 10 secondary schools in the City of Richmond were visited. Figure 3.1 and Figure 3.2 shows the location of the secondary schools in the Vancouver and Richmond School District.

Figure 3.1 Secondary School Map of the Vancouver School District



(Source: https://www.vsb.bc.ca/schools)

Figure 3.2 Secondary School Map of Richmond School District



(Source: http://www.sd38.bc.ca/schools/Secondary_Boundaries)

During school visits, the team was introduced and then the research project and the survey implementation options were described to the principals or vice-principals. If the principals or vice-principals were not available at the time, the team's contact information, description of the study, survey questionnaires (long and short), and the approval letter from the school board were left to the administrator to pass along to the principals or vice-principals. For schools who agreed to have their students participate in the in-class surveys, the principals or vice-principals sent out invitation to the teachers. Teachers who were interested in this study would then contact our research team to schedule a time for survey implementation. For

schools who were interested in conducting lunch time surveys, we sent emails to contact the principals and vice-principals to arrange the survey day. For schools which the team was not able to meet with the principals or vice-principals, follow-up emails were sent to describe our study and mention the team's earlier visit to the school and relevant documents were left to the administrator.

Surveys were conducted between October, 2011 and February, 2012. A total of eleven schools, six schools in the City of Vancouver and five schools in the City of Richmond participated in this study. One school participated in in-class survey, eight schools participated in lunch time survey, and two schools participated in both in-class and lunch time survey. Table 3.2 provides a summary of the implementation method, responses and the size of each school.

A total of 1032 responses were collected, of which 749 and 220 were from the lunch time and in-class survey, respectively. Three grade 8 Science classes, one grade 9 Science class, one grade 10 Leadership class, one grade 11 Science class, one grade 11 English class, one grade 11 Social Studies class, one grade 11/12 Marketing class and one grade 12 Accounting class participated in the in-class survey.

For this thesis, the data used for analysis was mainly from four common sections of the in-class and lunch time survey. Since the implementation method is different, the survey results are compared in section 4.5 to provide justification for combing the data collected. The comparison found no significant differences between the samples collected from the in-class and lunch time survey.

The team tried on a best effort basis to try and obtain as many comprehensive samples as possible so that the data collected would be a better representation of the students in the regions. Only the teachers that were interested would delegate their class time for our research team to conduct the survey. Due to this, we acknowledge the results may be biased as the principals and teachers who were interested in this study might have higher levels of pro-environmental attitudes which could have also influenced their students' attitudes.

Table 3.2 Implementation Method and Number of Responses by Schools

	In-Class	Lunch Time	Number responses	Enrollment[1]
City of Vancouver				
Windermere		✓	68	1332
Vancouver Technical		✓	105	1665
Kitsilano		✓	101	1471
Prince of Wales		✓	65	1294
Lord Byng		✓	91	1341
Sir Winston Churchill	✓		108	2100
City of Richmond				
H.J. Cambie		✓	93	853
R.C. Palmer		✓	53	736
Matthew McNair	✓	✓	116	930
Robert Alexander McMath	✓	✓	165	1249
Hugh Boyd		✓	63	826

[1] 2011/12 Source: http://www.bced.gov.bc.ca/reporting/school_data_summary.php

3.1.3 Questionnaire Design

The complete questionnaire contains nine sections: environmental attitudes and behavior, environmental assessment and knowledge, travel to school, attitudes toward travel modes, perception of cycling, environmental information acquisition, personal and household information and environmental belief and values. The short questionnaire contains four sections: environmental attitudes, environmental knowledge, travel to school, and personal and household information. Table 3.3 shows the comparison between the complete and short questionnaires. Table 3.4 provides a summary of the survey components. Both the complete and short questionnaires can be found in Appendix A.

With the exception of the environmental belief and values section which used the New Ecological Paradigm Scale (NEPs), all other questions were developed originally by the author with inputs from the teachers. The teachers drew from their experiences in the classroom, observation of the students and review of the curriculum. In particular, the science teachers provided quizzes and exams which were utilized as reference in the development of the

environmental knowledge questions. Select students volunteered to review the questionnaire and recommend revisions to make the language clearer to them.

Table 3.3 Survey Comparison

	Complete Survey	Short Survey
Environmental Attitudes	✓	✓
Environmental Behavior	✓	
Environmental Assessment and Knowledge	✓	✓
Travel to School	✓	✓
Attitudes toward Travel Modes	✓	
Perception of Cycling	✓	
Environmental Information Acquisition	✓	
Personal and Household Information	✓	✓
Environmental Belief and Values	✓	

Table 3.4 Survey Component

Section	Total	Detailed Components				
Environmental Attitudes		General Environmental	Government Intervention on environmental issues	General environmental issues related to transportation	Government intervention on environmental issues related to transportation	Change of Travel Behavior
# of Questions	17	5	3	3	4	2
Environmental Behavior		Perform in Private Space	Perform in the Public Space	Influence Other People to Perform Environmental Behavior		
# of Questions	13	4	5	4		
Environmental Assessment and Knowledge		Assessment on the City's Environmental Problem	General Knowledge	Transportation related knowledge		
# of Questions	16	2	8	6		
Travel to School		Commuting to School	Utilization of Travel Modes			
# of Questions	13	12	1			
Attitudes toward Travel Modes		Anticipated Travel Mode	Driving - Adult Identity	Transit and Social Image	Car Dependence	Car Pride
# of Questions	20	2	3	3	6	6
Perception of Cycling		Bike Ownership	Trip Purpose	Terms associated with Cycling	Statements on different aspect of Cycling	
# of Questions	5	2	1	1	1	
Environmental Information		General	Transportation			
# of Questions	6	3	3			
Personal and Household Information		Personal	Household			
# of Questions	15	7	8			
Environmental Belief and Values		The reality of limits to growth	Antianthropocentrism	The fragility of nature's balance	Rejection of exemptionalism	The possibility of an ecocrisis
# of Questions	15	3	3	3	3	3

Environmental Attitudes

Environmental attitudes were measured using fifteen statements to describe four types of environmental issues: general environmental problems, general environmental problems with government intervention, environmental issues related to transportation, and environmental issues related to transportation with government intervention. The five point Likert scale (strongly disagree, partially disagree, neutral, partially agree, or strongly agree) was used to establish a rating for each statement. Statements could be phrased positively or negatively, but they were coded so that higher scores indicated stronger pro-environmental attitudes. In addition, two questions were asked to understand if the respondent has changed and has encouraged other people to change their travel behavior because of environmental concern.

Environmental Behavior

Environmental behaviors were assessed using statements which describe 13 practices. The 13 practices were grouped into 3 categories: environmental behavior performed in private space, environmental behavior performed in public space and actions influencing others on environmental behavior. Respondents were asked to report the frequency of their environmental friendly behavior; their choices ranged from always, sometimes, rarely and never. For each statement, a respondent's environmental behaviors were scored as either "very friendly" (4), "friendly" (3), "neutral" (2), or "unfriendly" (1). Higher scores indicated greater pro-environmental behavior.

Environmental Assessment and Knowledge

At the beginning of the section, respondents were asked to evaluate the degree of seriousness of the environmental problems in Vancouver through two questions. Following that, respondents' knowledge about the environment was assessed through fourteen questions. The questions were designed in various difficulties in order to distinguish students with different knowledge levels: eight on general environmental knowledge and six on environmental knowledge specifically related to transportation. Each of the questions had four choices, one of which was the correct answer. To discourage participants from skipping over the questions, a

"do not know" option was not included. Each respondent's percentage of correct answers was used to assess his/her level of environmental knowledge. General knowledge and transportation-specific knowledge were measured separately.

Travel to School

Respondents were asked to report their to-school and after school trips of the previous school day. The details of the respondent's school trip were explored through a series of questions concerning the decision maker of the trip, factors that influence the current mode choice, who they travelled with, distance between their home and school, perceived safety of the trip, ideal travel time and ideal travel mode. Respondents were also asked to indicate the frequency of use for each travel mode.

Attitudes towards Transportation

Respondents' perception of different travel modes were explored through eighteen statements and two questions. The eighteen statements were used to quantify five subjective measures: car pride, car dependence, driving and adult identity, and transit and social image. Respondents were asked whether they strongly agree, agree, neutral, disagree, or strongly disagree with each statement. A Likert-scale was used to induce a rating (1 to 5) for each item. Potential scores for each measure are different as the number of statements for each subjective measure varies. Respondents were also asked to indicate their ideal mode of travel and whether or not they will buy a car in the future.

Perceptions of Cycling

Respondents' were asked to indicate their bike ownership, purpose of bike trips, and terms associated with cycling. Respondents' perception toward cycling was then explored through thirteen statements.

Environmental Information

The details of the environmental information that the respondent received were obtained through six questions concerning the source and potential impact of the information.

Personal and Household Information

Demographic information (gender, grade, car ownership, household income, number of household members, number of children in the household, driver licenses, and residency) concerning the respondent and the respondent's household was acquired through twelve questions.

Environmental Value

The New Ecological Paradigm Scale (NEPS), a set of 15 questions that elicits opinions on limits to growth, anthropocentrism, the balance of nature, human exceptionalism and ecological crisis is used to measure the environment value of the respondents. The respondents were asked whether they strongly agree, agree, neutral, disagree, or strongly disagree with each statement. A Likert-scale was used to induce a rating (1 to 5) for each item. Statements could be phrased positive or negatively, but they were coded so that higher scores indicated a more proecological view.

3.2 Data Entry and Data Screening

Data entry was accomplished with the assistance of two graduate students and two undergraduate students at the University of British Columbia. SurveyMonkey, web-based survey solution, was used for questionnaire development and data input. The data was then exported to Excel for data analysis. The data entry work commenced concurrently with the survey implementation. Each questionnaire is coded with a unique survey ID, which allowed for auditing to ensure that the data was inputted correctly.

Data screening was performed to remove records that have repeated patterns, illogical responses, and non-random missing values. Below are the criteria for removing the records.

1) The statements on environmental attitudes, travel modes, cycling and environmental values are phrased positively or negatively. Therefore, the records are removed if the respondent selected the same answer for all the statements. The only exception is that the respondent selected "Neutral".

2) The records are removed if the respondent answered their household consists of more than ten children, more than ten members with driver licenses and have zero or more than ten household members.
3) The records are removed if the respondent skipped an entire section

3.3 Data Validity

Confirmation on the validity and reliability of instruments are highly important to assure the integrity of study findings. Traditionally, validity of instruments has been determined by examining construct, content, and criterion-related concepts. In the paper "A Psychometric Toolbox for Testing Validity and Reliability", validity is defined as the ability of an instrument to measure the attributes of the construct under study; where construct is an explanatory variable which is not directly observable (DeVon, Block et al. 2007). Reliability on the other hand refers to the ability of an instrument to measure an attribute consistently. As described in the previous section, environmental attitudes were measured using fifteen indicators. Testing the validity and reliability of the factor-indicators groupings increases the strength of the subsequent structural equation models by introducing less error in the latent variables. This section first reviews the concepts of reliability and validity, and then describes the methods that are used in this study.

Cronbach & Meehl (1955) defined construct validity as the degree to which an instrument measures the construct it is intended to measure. An instrument is constructually valid if it has the capability to exclusively measure concepts that are theoretically and structurally related. However, if the instrument is also capable of measuring closely related concepts, then it might not have adequate construct validity as a measure of the construct. All types of validity fall under the broad heading of construct validity; under which are translational validity and criterion validity. Content and face validity are types of translational validity; whereas concurrent, predictive, convergent and discriminant are types of criterion validity (Trochim 2001).

Construct validity of an instrument can be evaluated via contrasted groups, hypothesis testing, and factor analysis. In the contrasted groups approach, two groups known to be high and low in the construct being measured are sampled. If the mean scores of the two groups differ significantly, then the instrument is valid. In other words, an instrument is constructually valid if it is capable of differentiating between two contrast groups. Another evaluation method is hypothesis testing, which is based on a theoretical approach. Construct validity is supported if the direction of scores on the measure reflects the framework as hypothesized. Factor analysis is a statistical method commonly used during instrument development to analyze relationships among large number of variables. Exploratory factor analysis (EFA) is used to identify the greatest variance in scores with the smallest number of factors. Confirmatory factor analysis (CFA) generally follows EFA and includes theoretical knowledge to further test the construct validity by validating the extent to which the statistical model fits the actual data (Waltz, Strickland et al. 2005). Munro (2005) suggests, in general, a minimum of five items per variable is recommended for factor analysis. Related test items define a part of the construct and are grouped together; whereas unrelated items do not define the construct and should be deleted from the tool.

Trochim (2001) defines content and face validity as types of translational validity. Content validity is indicated if the items in the tool sample the complete range of the attribute under study. A large pool of potential items is defined, which will then be reduced based on experts' review. However, establishing strong support for content validity can be a challenge. An estimate of validity is often inflated as experts endorse most items. In contrast, face validity is the easiest way to claim support for construct validity but also the weakest form of validity. It is a subjective assessment on the face of the construct which provides insight into how potential participants might interpret and respond to the measure.

Trochim (2001) further defines concurrent, predictive, convergent and discriminant as types of criterion validity. Criterion-related validity is indicated when measures on the predictor and the criterion variables are correlated; and the strength of the correlation substantially supports the extent to which the instrument estimates performance on each criterion (Waltz, Strickland et al.

2005). However, a faulty criterion-related validity estimate could occur due to criterion contamination. Criterion contamination, error in measurement of the criterion as an example, leads to an exaggerated correlation between instrument and criterion variables.

Concurrent criterion-related validity is confirmed when scores on a tool are correlated to a related criterion at the same point in time (Carmines and Zeller 1979). Predictive validity is referred to the degree to which test scores predict performance on some future criterion. High correlations between the original measure and criterion variables reinforce the conclusion that the tool is a valid predictor of the specified criteria. Convergent validity is a correspondence or convergence between constructs that are theoretically similar. The interitem correlation coefficients would be high in an instrument that has convergent validity. Conversely, discriminant validity is the instrument's capability to differentiate or discriminate between constructs that are theoretically different. Interitem correlation coefficients would be low in an instrument with discriminant validity.

Reliability refers to the ability of an instrument to measure an attribute consistently. It is a necessary but not sufficient component of the validity of an instrument. While the true score and error score cannot be known, the amount of both random and systematic error can often be controlled for. Stability reliability is tested when the attributes under study are not expected to change. On the other hand, equivalence reliability indicates whether all items in the tool reliably measure the attributes and if participants score similarly on like measures.

A form of stability reliability is performed through test-retest, which is estimated by administering the same test to the same group of respondents at different times. The correlation between the two scores, and often between individual questions, indicates the stability of the instrument. It should be noted that the major weaknesses of test-retest measures of reliability are the memory reactivity effects. The time interval should be long enough that respondents do not remember their original responses, but not long enough for their knowledge of the material to have changed. In general, the longer the time, the lower the reliability and the more likely that knowledge or attitudes actually have changed (Trochim 2005). Test-retest reliability is relevant for cognitive and trait scales that are not expected to

change over time. However, it is not appropriate for states that are expected to change over time, such as attitude, mood, or knowledge following an intervention.

As for equivalence reliability, Cronbach's alpha coefficient is the most frequently used statistics to show internal consistency reliability. Internal consistency indicates how well the items on a tool fit together conceptually. Cronbach's alpha coefficient is the only reliability index that can be performed with one test administration. It is a measure of the internal consistency for the test responses from the current participants and should be computed each time the test is administered (Waltz, Strickland et al. 2005). Higher coefficient alpha values can be achieved by adding correlated items (Nunnally and Bernstein 1994; DeVellis 2003). When non-correlated items are added, the value of alpha is reduced. Inflated alpha values are achieved when computed for an entire scale composed of two or more subscales. Each subscale should be computed individually as opposed to for the entire scale. In general, reliability coefficients around 0.90 are considered "excellent", values around 0.80 are "very good" and values around 0.70 are "adequate". If the reliability coefficient is below 0.50, most of the observed score variance is due to random error, an unacceptable amount of imprecision in most research (Kline 2010).

Another method for accessing equivalence reliability is through alternative forms, also known as parallel forms. Alternative forms reliability pertains to different versions of an instrument to determine reliability of scores. It can prevent participants from using knowledge gained from the first test. However, it should be noted that it may be difficult or impossible to generate sufficient items for two forms of a test if the entire content of items is small.

3.4 Analytical Methods

Factor analysis and structural equation modeling are used to test hypotheses made about the relationship between environmental knowledge, environmental attitudes and travel behavior. The first step is factor analysis which prepares the data for analysis by grouping a variety of indicators into cohesive factors. After the strongest factor-indicator relationships have been established, structural equation modeling is used to test the hypothesized relationships between the latent variables (factors) and the observed constructs. Both factor analysis and

structural equation modeling in this study are estimated in Mplus Version 5 (Muthen and Muthen 2007).

3.4.1 Exploratory and Confirmatory Factor Analysis

When studying travel behavior, the viewpoint is commonly transportation-agency-centric. The objective is focused on prediction based on standard economy theory. It is believed that choice behavior can be approximated via Random Utility Maximization (RUM) models, where perception, construal, and cognitive processes are well approximated by RUM models (Ben-Akiva, McFadden et al. 2002). Meanwhile, behavioral scientists have focused on demonstrations of how the assumptions of standard economics models often fail or why the decision processes are far from those assumed in standard theory (Loewenstein 2001). On the other hand, psychologists focus on understanding travel behavior via studying preference changes, how to manage and influence them. This customer-centric approach is defined from the viewpoint of the customer, encouraging planning agencies to recognize the connection between traveler preferences and the transportation systems. Gopinath (1995) suggests the economic and psychological choice theories are not antithetical but they can be utilized in conjunction with developments in psychometrics and econometrics to advance a richer class of choice models. McFadden (2000) foresaw the future of behavioral travel demand analysis as "The standard RUM model, based on a mildly altered version of the economists' standard theory of consumer behavior that allows more sensitivity of perceptions and preferences to experience, augmented with stated preference, perception, and attitude measures that uncover more of the process by which context molds choice, will increasingly become the dominant methodology for behavioral travel demand analysis." McFadden also acknowledges that reliable scales for stated preferences, perceptions, attitudes and reliable mappings from experience and information to perceptions and attitudes would be useful and can be obtained via comprehensive research effort.

This study takes a customer-centric approach in understanding travel behavior. Answers to survey questions regarding attitudes, perceptions, motivations, intentions are investigated via

factor analysis, which includes both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA).

Exploratory factor analysis (EFA) identifies the underlying structure of a large set of variables. . Researchers have no direct influence on the interaction between indicators and factors, hence the term "exploratory". The factor structure of the data is discovered via factor loadings and is tested against unrestricted factor models (Kline 2010). Data reduction can be achieved via selecting those variables that have the highest correlation with each factor. In terms of EFA application related to transportation, indicators can be grouped into factors to represent the different types of environmental attitudes, attitudes toward transportation, and perception toward cycling. Data reductions are then used to ensure that only the most appropriate indicators are analyzed. Confirmatory factor analysis (CFA) is used to determine if the number of factors and the loadings of indicators on them follow the hypothesis formed in pre-established theory or EFA. Factor loadings are the correlation coefficients between the indicators and the factors. If a factor loading is extraordinarily low or lower than that of the other indicators for that factor, the corresponding indicator should be considered for elimination from the analysis and should only be kept if the researcher feels it is important to the definition of the factor.

Goodness of fit measures should be examined to ensure that they are at an acceptable level. This ensures that the most appropriate factor-indicator groupings are being used, which increases the strength of the subsequent structural equation models by introducing less error in the latent variables.

3.4.2 Structural Equation Modeling

Structural equation modeling (SEM) tools are increasingly being used in behavioral science research for the causal modeling of complex, multivariate data sets in which the researcher gathers multiple measures of proposed constructs (Hair, Anderson et al. 1998). In particular, it has been used in modeling travel behavior and values (Golob 2003). SEM is a statistical technique for testing causal relationships between observed and unobserved variables where each unobserved variable is represented by a collection of observed variables. For example

attitudes could cause behavior, behavior could cause attitude or the causality could be in both directions, and SEM can be used to test such relationships.

The SEM method composes of a measurement model and a structural model. The measurement model is used to find the relationship between indicators and factors, while the structural model specifies and tests the theory-based hypotheses made about the relationship between endogenous (dependent) and exogenous (independent) factors and observed constructs. The links between a cause variable and an effect variable is a direct effect that is observable. Indirect effects between two variables are the effects along the paths between the two variables that involve intervening variables. The combination of direct and indirect effects creates the total effect and is used to specify latent variables as linear functions of other indicators in the model by deciding which of the parameters defining the factors are restricted to be zero, and which are freely estimated. Specification of each parameter allows the modeler to conduct a rigorous series of hypothesis tests regarding the factor structure. Similar to other statistical modeling, each hypothesis is accepted or rejected by examining the statistical significance of coefficients and the overall fit of the model is assessed using a variety of goodness of fit measures. Finally, R^2 values are reported for each of the endogenous variables which indicates how much of that construct's variance is explained by the model structure.

Many criteria have been developed for assessing goodness-of-fit of an SEM. This ensures that the most appropriate factor-indicator grouping are being used, which increases the strength of the subsequent structural equation models by introducing less error in the latent variables (Bentler 1990; Hu and Bentler 1999).

Most of these criteria are based on the chi-square statistic given by the product of the optimized fitting function and the sample size. The objective is to attain a non-significant model chi-square since the statistic measures the differences between the observed variance-covariance matrix and the one produced by the model.

There are problems associated with the use of the fitting function chi-square mostly due to the influence of sample size. For large samples, it may be very difficult to find a model that cannot

be rejected due to the influence of sample size. Many of the goodness-of-fit indices use normalization to cancel out the sample size in the chi-square functions, such as root mean square error of approximation (RMSEA) which measures the discrepancy per degree of freedom (Steiger and Lind 1980). RMSEA is one of the favored statistics because it is possible to compute its confidence interval as well as the mean value.

Steiger (1989), Browne and Mels (1990), and Browne and Cudeck (1992) offered guidelines for interpretation of the value of RMSEA. By analyzing many sets of empirical data and evaluating the behavior of RMSEA in relation to previous conclusions about model fit. Steiger (1989) and Browne and Mels (1990) arrived independently at the recommendation that values of RMSEA less than 0.05 be considered as indicative of close fit. Browne and Cudeck (1992) also suggested that values in the range of 0.05 to 0.08 indicate fair fit and that values above 0.10 indicate poor fit.

There are also goodness-of fit measures based on the direct comparison of the sample and the model-implied variance-covariance matrices including the standardized root mean square residual (SRMR), which ranges from 0-1, where large values mean high residual variance, and that such values reflect a poorly fitting model. It is generally accepted that the value less than 0.05 being considered a good fit (Hair, Anderson et al. 1998).

Bentler's comparative fit index (Bentler 1990) is another often used goodness-of-fit measure. CFI assesses the relative improvement in fit of the researcher's model compared with a baseline independence model, called the null model, which assumes zero population covariance among observed variables. A rule of thumb is that values greater than 0.90 may indicate reasonably good fit of the proposed model (Hu and Bentler 1999).

MacCallum et al (1996) suggested these guidelines are intended as aids for interpretation of a value that lies on a continuous scale and not as absolute thresholds. Kline (2010) recommended not to rely solely on thresholds for approximate fit indexes when deciding whether or not to re-specify a structural equation model because there are limitations to all approximate fit indexes. A healthy perspective on approximate fit indexes is to view them as providing qualitative or description information about model fit. The value of this information

increases when you report values of indexes that as a set of assess model fit from different perspective. The drawback is the potential for obfuscation, or the concealment of evidence about poor fit. This is less likely to happen if following a comprehensive approach to assess model fit that includes taking the model chi-square test seriously and describing patterns of residuals.

3.4.3 Multiple-Indicator Multiple-Cause (MIMIC) Analysis

The multiple-indicator multiple-cause (MIMIC) model estimates the measurement equations relating each factor to its indicators. A MIMIC factor has both cause indicators and effective indicators, and they can be continuous or categorical, where a categorical cause indicator represents group membership. A MIMIC factor with a single cause indicator and the rest as effect indicators is an equivalent version of a standard one factor CFA model.

3.4.4 Multiple Group Analysis (MGA)

Multiple group analysis (MGA), also known as multiple sample analysis or tests of invariance, is used to compare model fit across groups. The determination of overall model fit and individual parameters are the same as CFA and SEM. MGA is used to test the invariance or equality across the groups for factor loadings, factor variances/covariance, and structural coefficients.

3.4.5 SEM and its Application in Transportation

SEM has been widely applied to travel behavior research starting from 1980. More than 50 applications are cited by Golob (2003) in his 'Structural equation modeling for travel behavior research' review. These studies range from travel demand modeling using cross-sectional data, dynamic travel demand modeling, activity-based travel demand modeling, applications to capture attitudes, perceptions and hypothetical choices, organizational behavior and values, and driver behavior.

In the transportation field, causal relationships can exist in many forms. Previous research of causality includes: car ownership and distance traveled (Den Boon 1980); car ownership, season ticket ownership and modal usage (Axhausen, Simma et al. 2001); mode choice behavior and

attitudes (Tardiff 1977); mode choice and support for policies that benefit the environment (Golob and Hensher 1998); acceptance of road pricing, intention to reduce car use and feelings related to fairness and freedom (Jakobsson, Fujii et al. 2000). Dobson et al (1978) examined the attitude-behavior relationship and concluded that attitudes and choices form a two-way causality relationship. Morikawa and Sassaki (1998) conducted a Dutch survey to capture the influence of latent subjective attributes of choice alternatives on choices and came to similar findings that models with causality only from attitudes to behavior perform less well than those with causal links in both directions. In another study, Golob's research on mode choice and attitudes related to combined HOV and Toll lanes was inconclusive. Ory and Mokhtarian (2009) found travel amounts influence perceptions; and desires are shaped by both perceptions and affections. Choocharukul, Van and Fujii (2008) in psychological effects of travel behavior on preference of residential location choice found that preference regarding residential location was significantly affected by behavioral intention towards car usage.

Aside from causality, SEM was used to identify a reduced model which consists of factors that have higher correlation. Outwater et all (2003) identified three attitudinal factors which were used to partition the ferry-riding market into eight segments. This resulted in recognition that mode choices were different for market segments and these markets were sensitive to travel stress or the desire to help the environment. Kitamura and Susilo (2005) in a stability of travel patterns over time study found that changes in travel pattern are largely due to the instability of structural relationships while changes in demographic and socio-economic factors play relatively minor roles.

4 Environmental Knowledge, Attitudes and Travel Behavior

This chapter begins with descriptive statistics of the sample population, followed by a comparison between the sample population and the average household in the study area. The analysis on three key aspects of this research: environmental knowledge, environmental attitudes and travel behavior is then presented. Lastly, it compares the survey results between the samples collected from in-class surveys and lunch time surveys.

4.1 Demographic and Socioeconomics Information

Basic descriptive statistics and frequencies of responses to the twelve demographic questions are presented in Table 4.1 below. There are a total of 937 useable responses after data validation. When compared to the average household in metro Vancouver, respondents from the survey have a larger household size, have a higher household income, are less likely to live in an apartment and are more likely to live in single housing and own their own home (Table 4.2). This is expected as households with children represent larger household sizes and require larger homes. Also, typically households with children have higher household income and are financially stable to mortgage a home.

Table 4.1 Respondent and Household Characteristics

	Number responses	% of responses
Gender (N = 874)		
Male	348	40.3%
Female	515	59.7%
Grade (N = 866)		
8	169	19.5%
9	105	12.1%
10	186	21.5%
11	199	23.0%
12	207	23.9%
Number of Household Members (N =824)		
<=2	51	6.2%
3	148	18.0%
4	332	40.3%
5	171	20.8%
6+	122	14.8%
Number of Children in household (N = 833)		
0	13	1.6%
1	276	33.1%
2	373	44.8%
3	128	15.4%
4	27	3.2%
5	8	1.0%
6+	8	1.0%
Monthly Household Income (N = 438)		
Less than $25,000	94	21.5%
$25,000 to $49,999	68	15.5%
$50,000 to $74,999	94	21.5%
$75,000 to $99,999	61	13.9%
$100,000 to $149,999	50	11.4%
$150,000 and over	71	16.2%

Number of Household Licensed Drivers (N =830)		
0	22	2.7%
1	131	15.8%
2	372	44.8%
3	202	24.3%
4+	103	12.4%
Driver License (N=854)		
Yes	213	24.9%
No	641	75.1%
Number of Household Vehicles (N = 871)		
0	56	6.4%
1	309	35.5%
2	349	40.1%
3+	157	18.0%
Own Vehicle (N = 866)		
Yes	85	9.8%
No	781	90.2%
Dwelling Type (N = 814)		
House	560	68.8%
Duplex	41	5.0%
Townhouse	132	16.2%
Low Rises	48	5.9%
High Rises	33	4.1%
Other	0	0.0%
Residency (N = 857)		
Own	598	69.8%
Rent	233	27.2%
Other	26	3.0%
Years Living in Current Home		
less than 3 months	37	4.3%
3 months to 1 year	77	9.0%
1 year to 3 years	224	26.2%
3 years to 5 years	127	14.8%
more than 5 years	391	45.7%

Table 4.2 Comparison between Samples and Average Household

	Respondents	Greater Vancouver	City of Vancouver	City of Richmond
Population and Households				
Household Size	4.3	2.6	2.2	2.8
Number of cars per household	1.68	1.28	1.04	1.74
Household Average Income	76700	73258	68271	67440
Dwelling				
Owned	70.0%	40.4%	48.1%	76.3%
Rented	30.0%	59.6%	51.9%	23.7%
Single-detached house	69.0%	10.4%	19.1%	41.1%
Semi-detached house	5.0%	1.2%	1.5%	3.0%
Row house	16.0%	14.7%	3.2%	19.1%
Apartment	10.0%	73.4%	76.1%	36.3%

4.2 Environmental Knowledge

Table 4.3 lists the environmental knowledge questions that students responded to, the correct answer for each question and percentage of students who responded correctly. Students in general have low level of knowledge about the environment. On average, they answered 6.86 of the fourteen questions correctly (Standard Derivation = 2.45), with only 1% of respondents answering more than 80% of the questions correctly (Figure 4.1). The average percentages of correct answers for both general and transportation-specific questions were 49%. Amongst general knowledge (GENKNOW) related questions, question #5 regarding the definition of organic food had the most number of correct responses (67%). Question #2 regarding ecological footprint had the fewest number of correct responses (15%). Amongst transportation-specific knowledge (TRANKNOW), question # 9 regarding the transportation method that creates the least pollution had the most number of correct responses (87%). Question #14 regarding the percentage of the world's total CO2 emission attributable to the transport sector had the fewest number of correct responses (31%).

Figure 4.2 analyses general and transportation-specific environmental knowledge by demographic and socioeconomic variables. A series of ANOVA tests, reported in Appendix B,

found significant differences in general knowledge (GENKNOW) and transportation-specific knowledge (TRANKNOW) for the whole sample at the 5% level, and significant differences in GENKNOW by driver's license status and owning personal vehicle, significant differences in TRANKNOW by number of household people, number of children in the household and years living in a home at the 5% level. Overall, there is slight increase along the grades in either general or transportation-specific knowledge but the difference is not statistically significant.

These bivariate analysis results serve as exploratory purpose only. For example, students with a driver license have better environmental knowledge, possibly because students with a driver license are in higher grades and are more informed, as opposed to a direct correlation with having a driver license. This becomes clearer in the multivariable analysis in the SEM models: after demographic and socioeconomic variables are controlled, driver's license status no longer plays a significant role in explaining environmental knowledge.

Figure 4.1 Number of Environmental Knowledge Questions Answered Correctly

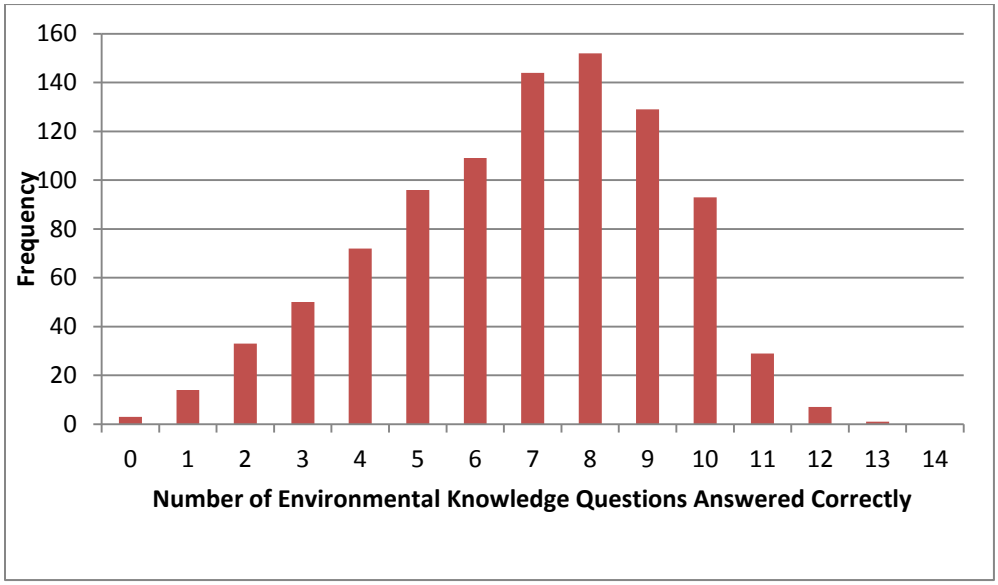
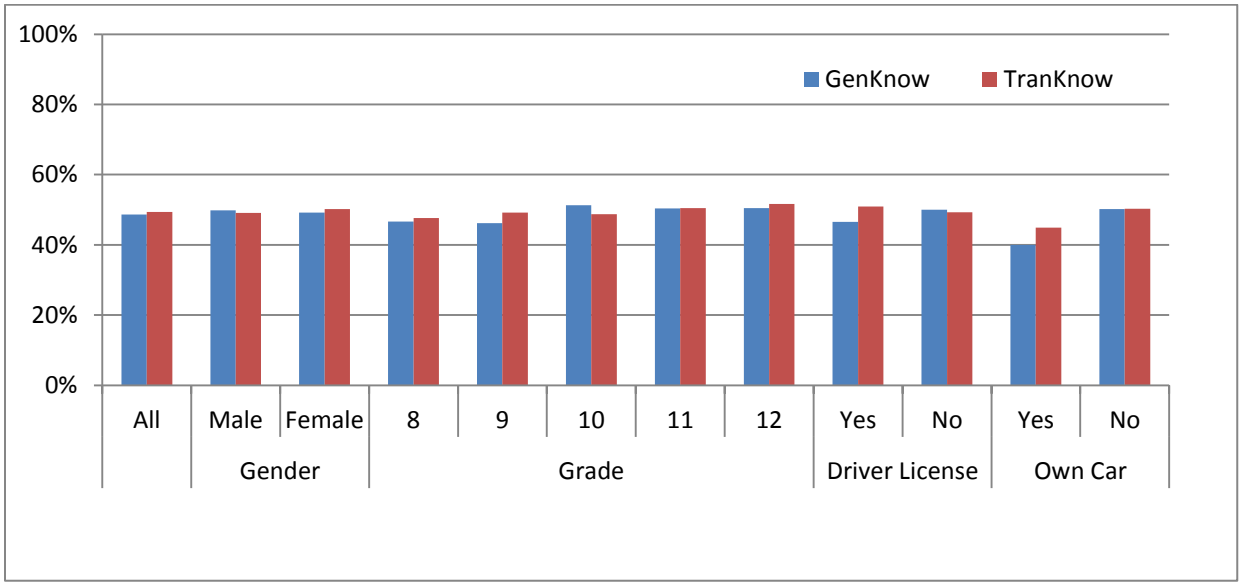


Figure 4.2 Average levels of GENKNOW and TRANKNOW




100%
80%
60%
40%
20%
0%
GenKnow
TranKnow
0
1
2
3
4+
Own
Rent
Other
less than 3 months
3 months to 1 year
1 year to 3 years
3 years to 5 years
more than 5 years
Dwelling
Residency
Years Living in Current Home

Table 4.3 Environmental Knowledge Questions and Responses

Q	General	Correct %
1	**Clothes Washing powder causes water pollution mainly because it contains:** Phosphorus	28%
2	**Which of the following statement about ecological footprint is not correct?** Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle.	15%
3	**The carbon of "carbon emissions" refers to:** Carbon dioxide	59%
4	**Which of the following waste materials can not be recycled?** Expired drugs	64%
5	**Organic food means:** Food produced without using synthetic pesticides, hormones, food additives and other production	67%
6	**Which country is the world's largest oil consumer?** United States	54%
7	**Which of the following statements about greenhouse effect is incorrect?** Increased concentration of carbon dioxide in recent decades is a natural occurring process, not as a result of human activity.	46%
8	**Biodiversity means:** Diversity of Biological species, ecosystem and gene multiplicity	56%
	Transportation	
9	**Which of the following transportation method create the least pollution?** Cycling	87%
10	**Which of the following transport sector has the highest energy consumption in Canada?** Highways	54%
11	**Which of the following strategy does not reduce CO2 emission in urban transport?** Reduce public transportation services	32%
12	**What percentage of British Columbia's greenhouse gas emissions come from Metro Vancouver cars?** 35%	42%
13	**Which of the following type of fuel produce the most carbon dioxide emissions?** Petroleum-based fossil-fuels	50%
14	**What percentage of the world total CO2 emission does transport sector account for?** 25%	31%

4.3 Environmental Attitudes

The environmental attitudes statements that students responded to are listed in

Table 4.4 along with their corresponding Likert scale results. As shown in

Table 4.4, environmental attitudes can be parsed into four different attributes; including general environmental problems, general environmental problems with government intervention, environmental issues relating to transportation, and environmental issues related to transportation with government intervention. While all these attributes relate to the larger environmental attitudes factor, they each represent a distinct concept and possibly interact with other factors in varied ways. In section 4.3.1, factor analysis is used to confirm the appropriate grouping of statements into multiple factors.

In general the students in this study have attitudes that are protective of the environment. The average environmental attitudes score was 3.4 and 75% of students have positive environmental attitudes. Four indicators on a scale of 1 to 5 (x1, x2, x3 and x4) were used to quantify the students' general environmental attitudes. Indicator x1, "being environmentally responsible is important to me", served as an overall assessment and 76% of the respondents agreed. Indicators x2, x3 and x4 probed students' environmental attitudes in terms of the compromise between environmental protection and other factors: 23% agreed that we should not have to be inconvenienced in our daily lives in order to protect the environment; 11% thought that he/she did not need to protect the environment if people around him/her did not pay attention to the environment; and 26% said the economic development in Canada is more important than environmental protection.

Three indicators (x5, x6 and x7) were used to quantify the students' general environmental attitudes toward government intervention. While 23% stated that "the government shouldn't force people to change in order to protect the environment", 64% agreed that "the government should take more lead in protecting the environment even if people don't like it", and 67% agreed that "the government should legislate on categorizing wastes into recyclable categories".

Four indicators (x8, x9, x10 and x11) were used to quantify the students' environmental attitudes towards transportation issues: 20% thought that "it is important to build more roads to reduce congestion even if it will increase pollution"; 62% believed that "we should reduce car usage to reduce pollution"; 66% said that "in order to protect the environment, I would

cycle and walk more because these modes of transportation do not pollute"; and 30% agreed that "the purchase and use of private cars is freedom of choice; I will buy and use them even if it will damage the environment".

Four indicators (x12, x13, x14 and x15) were used to quantify the students' environmental attitudes towards government intervention on transportation issues. 55% stated that "the government should provide incentives to people who travel by electric vehicles, public transport, bicycle or on foot. 44% do not think that the government should encourage the use of cars in the city to stimulate economic growth through increase consumption. However, only 22% agreed that car users should pay higher taxes for the sake of the environment, and only 24% agreed that the government should raise the price of gasoline to reduce congestion and air pollution.

Table 4.4 Responses to Environmental Attitudes Statement

	Survey Statement	Strongly Agree	Moderately Agree	Neutral	Moderately Disagree	Strongly Disagree
	General environmental issues					3.58
x1	Being environmentally responsible is important to me	29%	47%	21%	2%	1%
X2	We should not have to bring inconvenience to our daily lives in order to protect the environment	7%	19%	34%	28%	12%
X3	I do not need to protect the environment if people around me do not pay attention to the environment	4%	7%	18%	28%	42%
X4	In the current state of Canada, economic development is more important than the protection of the environment	8%	18%	37%	24%	13%
	Government interventions on environmental issues					3.66
X5	The government shouldn't force people to change in order to protect the environment	7%	16%	36%	29%	11%
X6	The government should take more lead in protecting the environment, even if people don't like it	28%	35%	26%	7%	3%
X7	The government should legislate on categorizing wastes into recyclable categories	36%	32%	26%	4%	2%
	Transportation related environmental issues					3.30
X8	It is important to build more roads to reduce congestion even if it will increase pollution	6%	15%	37%	28%	15%
X9	We should reduce car usage to reduce pollution	31%	32%	23%	9%	5%
x10	In order to protect the environment, I would cycle and walk more, because these mode do not pollute	32%	34%	24%	8%	3%
x11	Purchase and use of private cars is freedom of choice, I will buy and use even if it will damage the environment, even if people don't like it	10%	21%	44%	16%	9%
	Government interventions on environmental issues related to transportation					3.10
X12	For the sake of the environment, car users should pay higher taxes	6%	17%	34%	24%	20%
X13	The government should raise the price of gasoline to reduce congestion and air pollution	8%	16%	28%	25%	23%
X14	The government should encourage the use of cars in the city to stimulate economic growth through increase in consumption	7%	9%	40%	26%	18%
X15	The Government should provide incentives to people who travel by electric vehicles, public transport, bicycle or on foot	27%	29%	35%	5%	4%

4.3.1 Factor Analysis

Confirmatory Factor Analysis (CFA) is used to validate the hypothesized groupings. Since there were strong beliefs as to which indicators could be mapped into which factors, exploratory factor analysis was not necessary. In the first iteration of CFA, the goodness of fit measures were not acceptable (see Table 4.5). Cronbach's alpha for all four environmental attitudes factors are below 0.60, suggesting low internal consistency among the indicators. To improve the fit and internal consistency, the fifteen indicators are organized into two main factors. X1 to x7 are grouped into general environmental attitudes (GENATT) and x8 to x 15 are grouped into transportation-specific environmental attitudes (TRANATT). In the second iteration of CFA, the goodness of fit measures were still not acceptable (see

Table 4.6), but the Cronbach's Alpha was around 0.70 for both GENATT and TRANATT, suggesting a reasonable level of internal consistency among the indicators.

Table 4.5 Goodness of Fit Results for Confirmatory Factor Analysis (1st model)

Overall Model Fit	
Observations	937
Chi-Square	953.5
Degree of Freedom	84
CFI	0.690
TLI	0.613
RMSEA	0.105
90% CI of RMSEA	0.099~0.111
SRMR	0.08

Table 4.6 Goodness of Fit Results for Confirmatory Factor Analysis (2nd model)

Overall Model Fit	
Observations	937
Chi-Square	976.5
Degree of Freedom	89
CFI	0.684
TLI	0.627
RMSEA	0.103
90% CI of RMSEA	0.097~0.109
SRMR	0.081

To improve the fit, the correlation matrix is examined to determine if any indicators could be eliminated (Table 4.7). x14 is removed from TRANATT since it has low correlation with the other indicators. The Cronbach's alpha for TRANATT changed from 0.69 to 0.68 after removing x14.

The next step in improving the goodness of fit measures was to use modification indices to identify indicators whose error terms might be correlated. There are eleven indicator pairs that were predicted to improve the fit the most by allowing for correlation among error terms. This correlation suggests that each indicator is being affected by a third unmeasured variable. For instance, one pair of correlated indicators was "for the sake of the environment, car users should pay higher taxes" and "the government should raise the price of gasoline to reduce congestion and air pollution". Both indicators suggest car users should pay higher prices in order to reduce car usage. Allowing the error terms to be correlated accounts for this similarity and improves the model fit. Final CFA goodness of fit results are shown in Table 4.8 with the detailed results shown in Table 4.9. CFI statistics are greater than 0.9, RMSEA statistic less than 0.06 and SRMR statistic less than 0.05 providing a good indication that the model has a reasonable fit.

Table 4.7 Correlation Matrix

	x1	x2	x3	x4	x5	x6	x7	x8	x9	x10	x11	x12	x13	x14	x15
x1	1.00														
x2	0.13	1.00													
x3	0.29	0.33	1.00												
x4	0.20	0.27	0.34	1.00											
x5	0.10	0.41	0.24	0.27	1.00										
x6	0.31	0.22	0.27	0.23	0.20	1.00									
x7	0.26	0.16	0.22	0.18	0.11	0.39	1.00								
x8	0.09	0.27	0.29	0.29	0.23	0.18	0.09	1.00							
x9	0.28	0.16	0.24	0.12	0.14	0.34	0.20	0.21	1.00						
x10	0.40	0.14	0.29	0.15	0.12	0.35	0.22	0.12	0.40	1.00					
x11	0.20	0.24	0.28	0.32	0.27	0.21	0.06	0.24	0.20	0.22	1.00				
x12	0.36	0.14	0.05	0.18	0.17	0.24	0.14	0.12	0.27	0.32	0.24	1.00			
x13	0.25	0.05	0.00	0.05	0.06	0.23	0.09	0.07	0.32	0.28	0.16	0.52	1.00		
x14	0.12	0.32	0.43	0.35	0.33	0.24	0.20	0.38	0.17	0.17	0.24	0.08	-0.01	1.00	
x15	0.19	0.16	0.18	0.11	0.10	0.32	0.26	0.09	0.26	0.29	0.14	0.17	0.11	0.14	1.00

Table 4.8 Goodness of Fit Results for Confirmatory Factor Analysis (3rd model)

Overall Model Fit	
Observations	937
Chi-Square	270.2
Degree of Freedom	65
CFI	0.917
TLI	0.883
RMSEA	0.058
90% CI of RMSEA	0.051~0.065
SRMR	0.049

Table 4.9 Confirmatory Factor Analysis Results for Environmental Attitudes

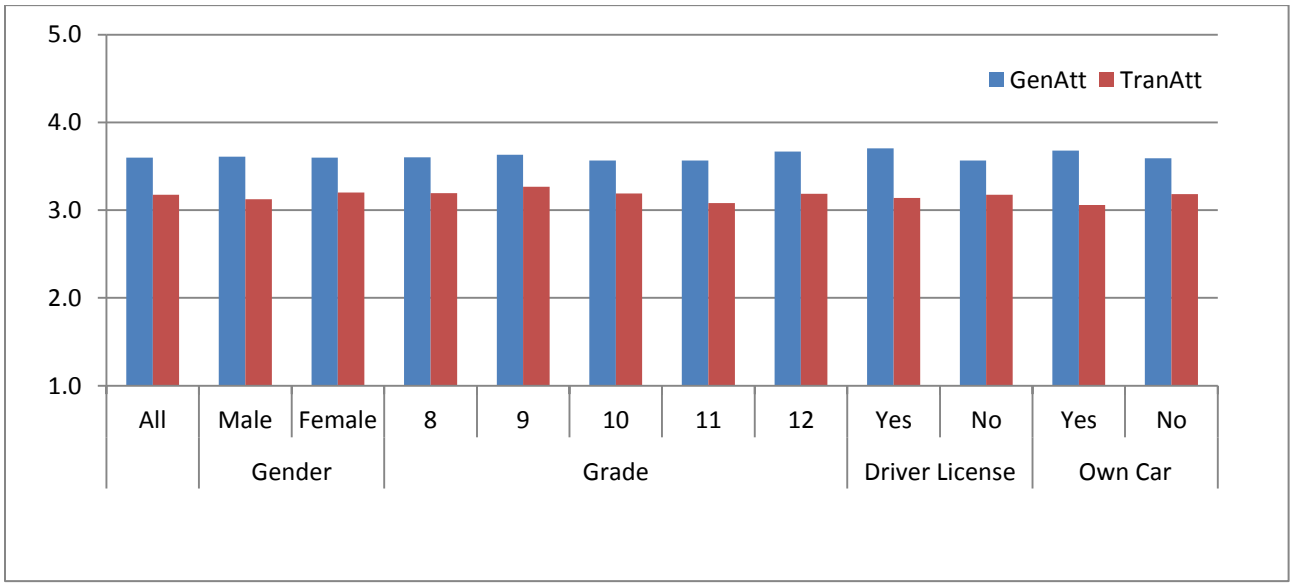
Factor	Indicator	Estimate	S.E.	Est./S.E.	P-Value
GENATT	Being environmentally responsible is important to me	0.491	0.031	16.052	0.000
	We should not have to bring inconvenience to our daily lives in order to protect the environment	0.422	0.032	12.989	0.000
	I do not need to protect the environment if people around me do not pay attention to the environment	0.633	0.03	20.93	0.000
	In the current state of Canada, economic development is more important than the protection of the environment	0.437	0.032	13.684	0.000
	The government shouldn't force people to change in order to protect the environment	0.361	0.034	10.615	0.000
	The government should take more lead in protecting the environment, even if people don't like it	0.624	0.031	20.039	0.000
	The government should legislate on categorizing wastes into recyclable categories	0.384	0.035	10.975	0.000
TRANATT	It is important to build more roads to reduce congestion even if it will increase pollution	0.37	0.034	10.943	0.000
	We should reduce car usage to reduce pollution	0.557	0.03	18.804	0.000
	In order to protect the environment, I would cycle and walk more, because these mode do not pollute	0.593	0.028	20.868	0.000
	Purchase and use of private cars is freedom of choice, I will buy and use even if it will damage the environment, even if people don't like it	0.453	0.032	14.176	0.000
	For the sake of the environment, car users should pay higher taxes	0.476	0.033	14.643	0.000
	The government should raise the price of gasoline to reduce congestion and air pollution	0.356	0.037	9.661	0.000
	The Government should provide incentives to people who travel by electric vehicles, public transport, bicycle or on foot	0.419	0.033	12.717	0.000

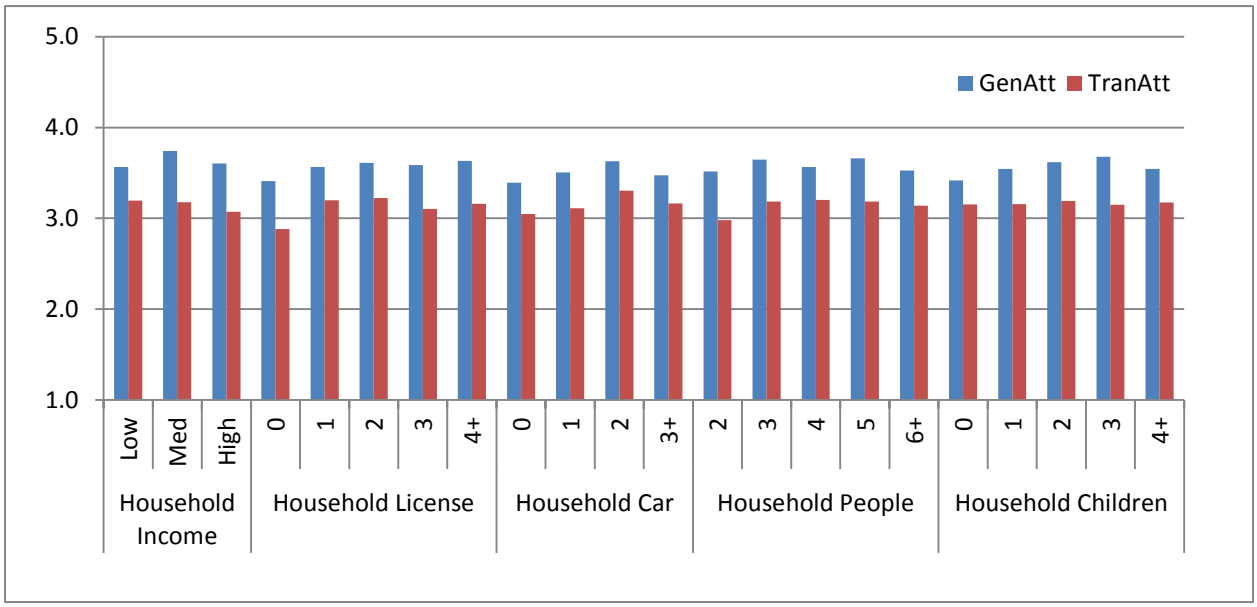
4.3.2 Determinants of Environmental Attitudes

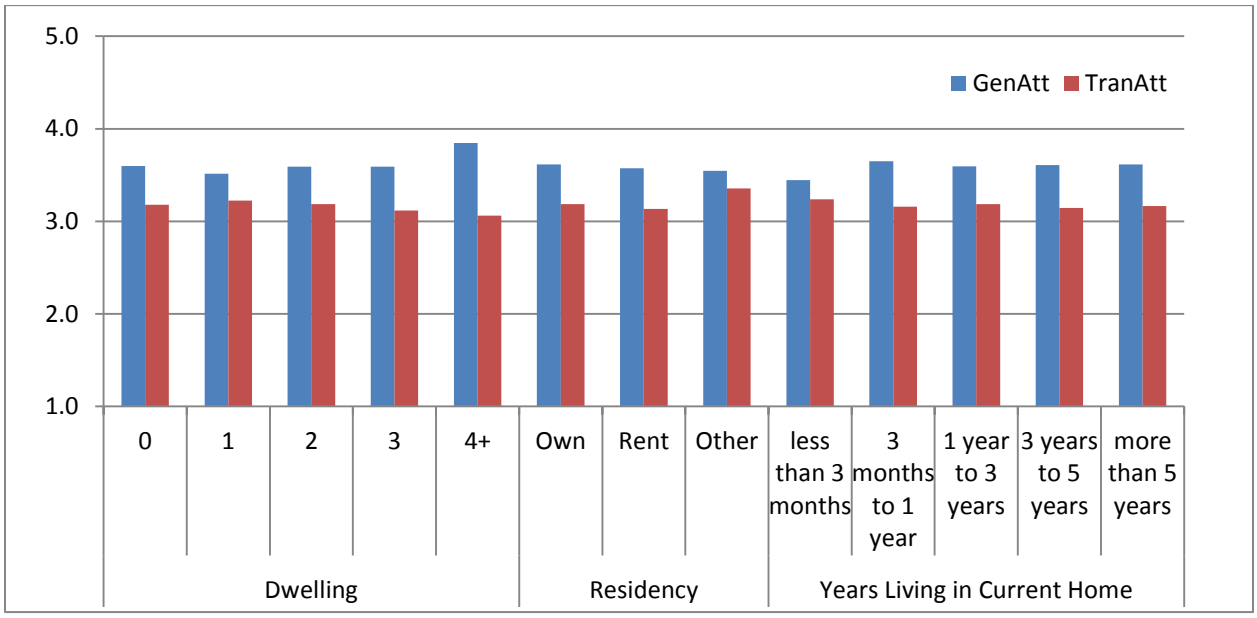
Figure 4.3 analyses general and transportation-specific environmental attitudes by demographic and socioeconomic variables. Overall, the students have more positive general attitudes than transportation-specific environmental attitudes. The average GENATT score was

3.6 and the average TRANATT score was 3.2. A series of ANOVA tests, reported in Appendix B, found significant differences between GENATT and TRANATT for the whole sample at the 5% level, significant differences in GENATT by income and driver's license status, and significant differences in TRANATT by household driver licenses at the 5% level. For example, students in mid-income households have more positive general environmental attitudes than students in low and high income households, but the income difference did not influence the students' transportation-specific environmental attitudes. For both general and transportation-specific environmental attitudes, there is no significant difference between grade 8 and 12. It suggests that the students' environmental attitudes did not change during their education in high school.

Figure 4.3 Average levels of GENATT and TRANATT




5.0
4.0
3.0
2.0
1.0
GenAtt
TranAtt
Low
Med
High
0
1
2
3
4+
0
1
2
3+
2
3
4
5
6+
0
1
2
3
4+
Household Income
Household License
Household Car
Household People
Household Children


5.0
4.0
3.0
2.0
1.0
GenAtt
TranAtt
0
1
2
3
4+
Own
Rent
Other
less than 3 months
3 months to 1 year
1 year to 3 years
3 years to 5 years
more than 5 years
Dwelling
Residency
Years Living in Current Home

4.4 Travel Behavior

The students were asked to report their school trips for the previous school day. Of the different modes to get to school, walking is the main utilized mode, which accounts for 36% of all journeys (Figure 4.4). 35% of students travelled to school by car, with 12% as car driver and 23% as car passenger. 23% took public transit or school bus and only 3% of student biked to school. The travel modes used for after school trips are slightly different. Fewer students are being driven and shifted to increase in walk mode and public transit.

In contrast, students' ideal travel mode differs from their actual travel mode. 23% of the students prefer to drive and 11% prefer to bike to school; however, only 11% actually drive and 3% actually bike. On the other hand, fewer students prefer to take public transit or walk to school (7% less for each mode)

Looking into gender comparison, more female students are being driven and fewer bike to school compared to male students. This is consistent with the results of students' ideal mode of travel where more female students prefer to be car passengers and more male students prefer to bike to school. In addition, male students have a stronger desire to drive than female students.

Looking into grade comparison, grade 12 students are more likely to drive, where approximately one-fifth of them drive to/from school. While this is expected, as citizens in British Columbia are required to be 16 or older to qualify for a learner's license and need to stay in the learner's stage for at least 12 months in order to be qualified to take the road test, roughly 20% switched to driving as soon as the option was available. This suggests the preference to driving might actually be higher as not all grade 12 students have the option to drive, depending on access to vehicle and whether they have successfully obtained the driver license.

An interesting observation is the decline in the share of after school trips made by car passenger and increase in the share of after school trips made by transit across the grades. For example, the share of after school trips for grade 8 students made by car and by public transit is 23% and 7%, respectively. In contrast, the share of after school trips for grade 12 students made by car and by public transit is 7% and 20%, respectively.

Trip purposes of trips made directly after school are shown in Figure 4.5. The majority of students (65%) return home after school. Trips for social and recreational purposes make up the majority (10%) of the after-school trips away from home. Personal business, dining out, shopping and work purposes together make up 15% of trips There is a decline in the percentage of trips made directly home for students in higher grades. This implies that the tendency to engage in out-of-home activities after school increases with age.

The average travel time to school is 16 minutes, with 52% of the students travelled for less than 15 minutes and 84% travelled for less than 30 minutes (

Figure 4.6). The average travel time to school by walking, biking and car is 14 minutes. The travel time is similar for walking, biking and car suggest that the students who travel to school by car live further away from the school. Travel to school by public transit takes 28 minutes, which is almost twice as much the time compared to the other modes.

The average travel time after school is 27 minutes, which is much longer when compared to the average travel time to school, with 28% of students travel for more than 30 minutes. On average, students who do not go directly home take almost twice the time than the students that go directly home after school (41 minutes compared to 21 minutes). This could be that the distance to the students' after school activities are further away from their home. It is also interesting to note that the travel time for the after school trip generally increases with age. This finding agrees with the earlier finding that older students are more likely to engage in out-of-home activities after school and therefore travel for a longer time.

Figure 4.4 Travel Mode to/from School

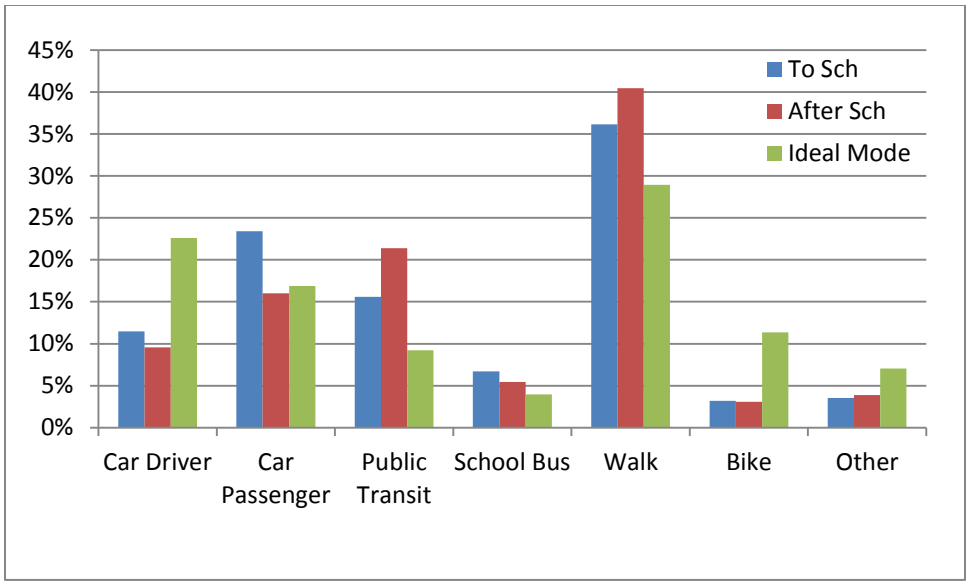


Figure 4.5 Activities after School

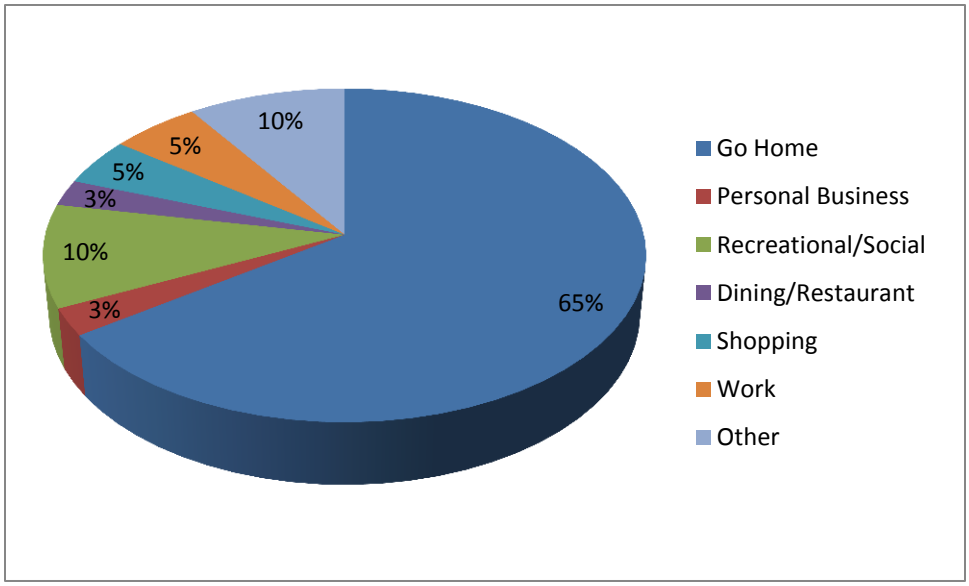
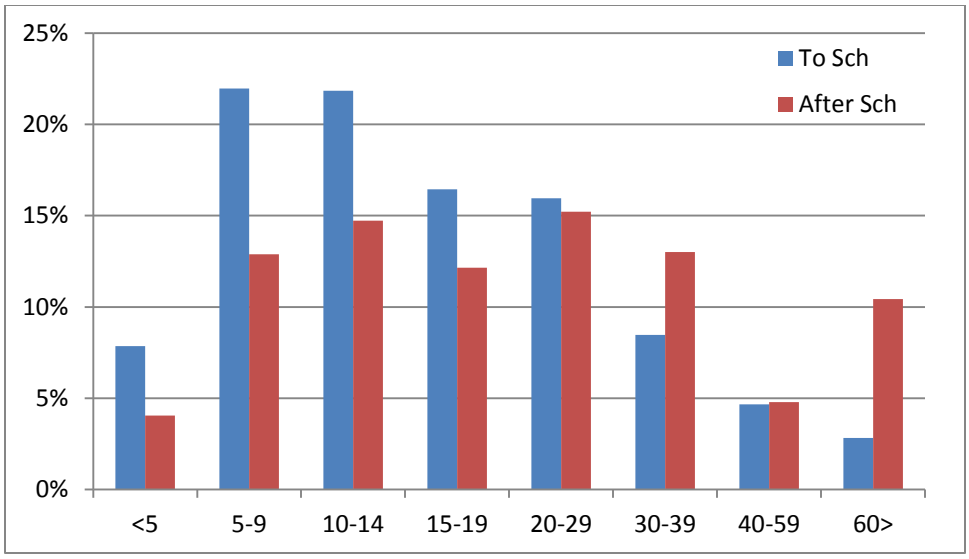


Figure 4.6 Travel Time to/from School



The students were asked if they travel to school with a companion. Table 4.10 shows the percentage of school trips in which students traveled by themselves, by grades and gender. 42% of students travelled to school by themselves, and the others mostly travelled with their classmates and siblings. Only 3% travelled to school with their parents. In general, older students (grade 10-12) tend to make a larger share of school trips unaccompanied than younger students (grade 8-9). As older students are more likely to have after school activities, the share of trips made alone is expected to be greater.

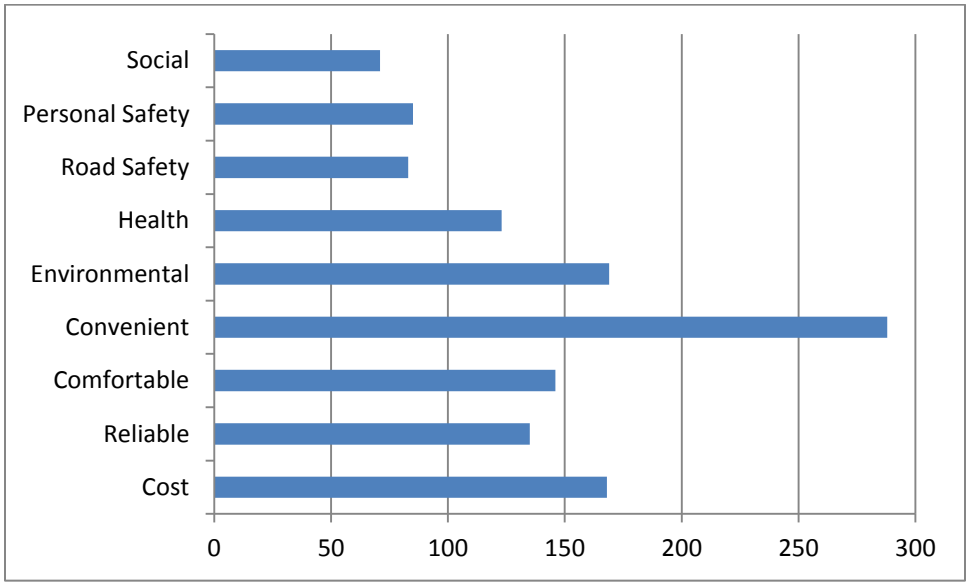
In addition to the differences across grades, there are differences between genders. On average, male students made more school trips alone than females, where 47% of male students traveling unaccompanied but only 39% of female students traveling unaccompanied.

Table 4.10 Travel Alone to School by Age and Sex

Grades	Male	Female	Total
8	31%	32%	32%
9	48%	26%	32%
10	47%	44%	45%
11	54%	43%	47%
12	55%	38%	44%
Total	47%	39%	42%

The students were asked about the decision making process of their commuting mode choices to school. 61% of students were the sole decision makers in their commuting mode choice while the rest having their parents and guardians as decision maker. Male students and higher grade students have a higher tendency to make their own commuting decision. The students were further asked to identify the factors that influence their current travel mode choice to school. As presented in Figure 4.7, convenience is the most important factor, followed by environmental and cost. Personal safety and road safety is not the driver of the mode choice to school because the majority of students rate their daily commute to school to be either very safe or safe.

Figure 4.7 Factors that Influence the Travel Mode Choice to School



Besides their school trips, the students were also asked to report the average use of each travel mode. As shown in Table 4.11, walking is the most commonly used mode of transport, with 86% of students walking at least once a week and 63% at least 5 days a week. On the other hand, biking is one of the least used modes of transport, with only 7% of students who bikes at least 5 days a week and 20% at least once a week. 41% of students had never biked before.

An interesting observation is the difference between the frequency of bike use and the travel mode share of bike to school. 7% of students bike at least 5 days a week while only 3% of students bike to and from school. An explanation could be that these results are affected by the seasonal variation of cycling which is much more dependent on weather than are other modes. Students were asked to report their school trip for the previous school day which is during the winter months. However, cyclists may respond the average frequency over the whole year. This suggests the mode share to and from school could be different if the survey is conducted during the warmer months. Another explanation could be that the students bike for recreational purposes after school or during the weekend.

The car is the second most frequent used mode of transport, followed by walking. 45% of students travelled as car passengers at least 5 days a week and 79% at least once a week. 12% of students drive a car at least 5 days a week and 27 % at least once a week.

In terms of public transportation, buses are more commonly used than the SkyTrain and commuter rail. While 55% of students use buses at least 5 days a week, only 39% use the SkyTrain and commuter rail at least 5 days a week. On average, 15% of students have never used of public transportation before.

Table 4.11 Percentages of Frequent Use of Modes of Transport

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	once a fortnight	once a month	less often	never
Walk	43%	20%	12%	11%	3%	3%	4%	4%
Bike	3%	4%	6%	7%	5%	6%	28%	41%
Public Transit Buses	16%	13%	10%	16%	9%	9%	15%	12%
School Buses	2%	4%	1%	2%	1%	1%	6%	82%
Sky Train / Commuter Rail	6%	5%	10%	18%	12%	12%	20%	17%
Taxi	2%	1%	2%	3%	3%	3%	20%	66%
Car Driver	8%	4%	7%	7%	2%	2%	6%	64%
Car Passenger	31%	14%	18%	16%	4%	3%	5%	10%

Table 4.12 shows the modes people use to travel to work in the region, and compares with the modes students use to travel to school. Car driver has a significantly higher mode share for journey to work compared to the journey to school, but car passenger has a smaller share for journey to work compared to the journey to school. Among the modes of active transportation, walk mode share is substantially higher for journey to school compares to the journey to work. However, bike mode share is similar for both types of journey.

Table 4.12 Travel Mode to Work vs Travel Mode to School

Travel Mode	To Work			To School
	Metro Vancouver	City of Vancouver	City of Richmond	
Car Driver	67%	52%	73%	11%
Car Passenger	7%	6%	9%	23%
Public transit	17%	25%	12%	16%
Walk	6%	12%	4%	36%
Bike	2%	4%	1%	3%
Other	1%	1%	1%	10%

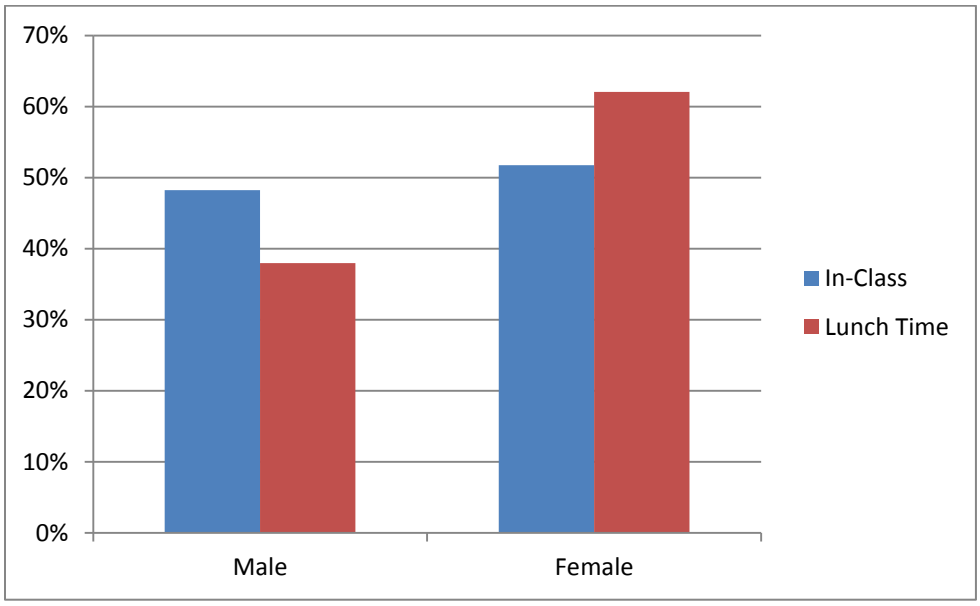
(Source: Statistics Canada, 2006 Census)

4.5 Comparison between In-class and Lunch Time survey

Of the 937 useable responses, 77% were collected from lunch time surveys and the rest were collected from in-class surveys. The students that participated in the in-class surveys had a dedicated 30 minutes to fill out the complete version of the questionnaire under teachers' supervision. On the other hand, the students that participated in the survey during lunch time filled out the short version of the questionnaire at the cafeteria on a voluntary basis without teachers' supervision. Since the implementation method is different, this section provides a comparison between the data collected from the lunch time and in-class survey.

The overall distribution of gender was 40% male and 60% female (Figure 4.8). However, the in-class survey is more evenly distributed, with 48% male and 52% female. This indicates the lunch time surveys have over sampled female students. As reported by the surveyors, female students, in general, are more interested in participating in surveys than male students.

Figure 4.8 Gender by survey type



The distribution of grades for the overall, in-class and lunch time samples are presented in Figure 4.9. For the in-class surveys, a significant higher proportion of responses were collected

from grade 8 students (36%). Grade 9, 10 and 12 altogether only represented 41% of the samples. Of the lunch time surveys, grade 10, 11 and 12 students each represented a quarter of the responses. Grade 8 and 9 altogether only represented 26% of the sample.

Figure 4.10 reports the average percentage of correct answers for general and transportation-specific environmental knowledge questions by survey type and Figure 4.11 reports the average level of general and transportation-specific environmental attitudes by survey type. No significant differences in environmental knowledge and attitudes were observed between the samples collected from lunch time surveys and in-class surveys.

Figure 4.9 Grade by survey type

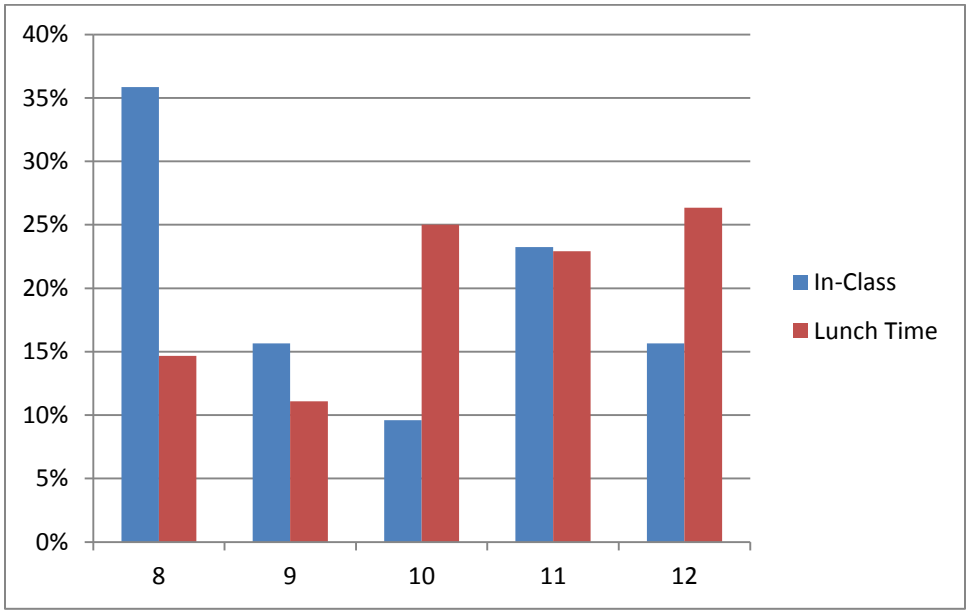


Figure 4.10 Environmental Knowledge by survey type

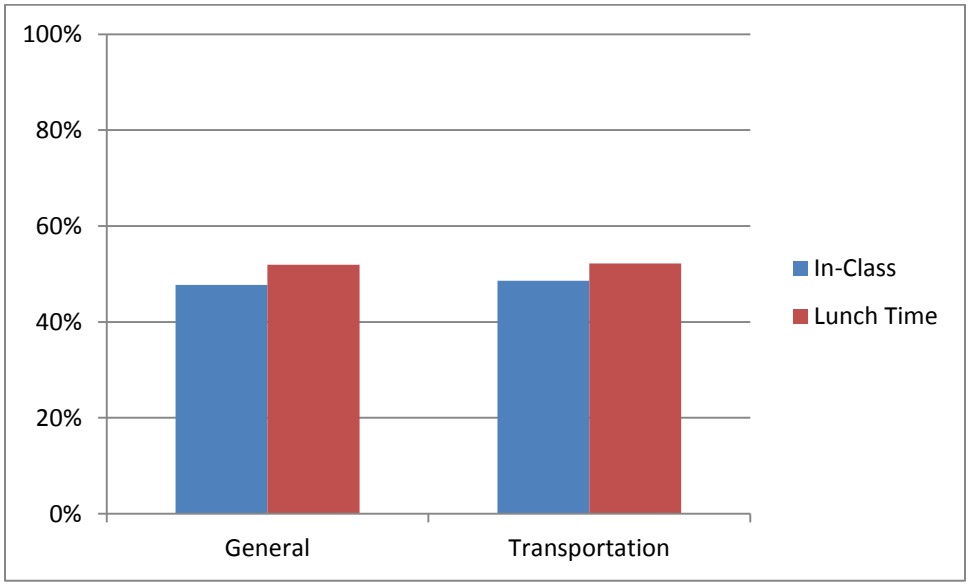
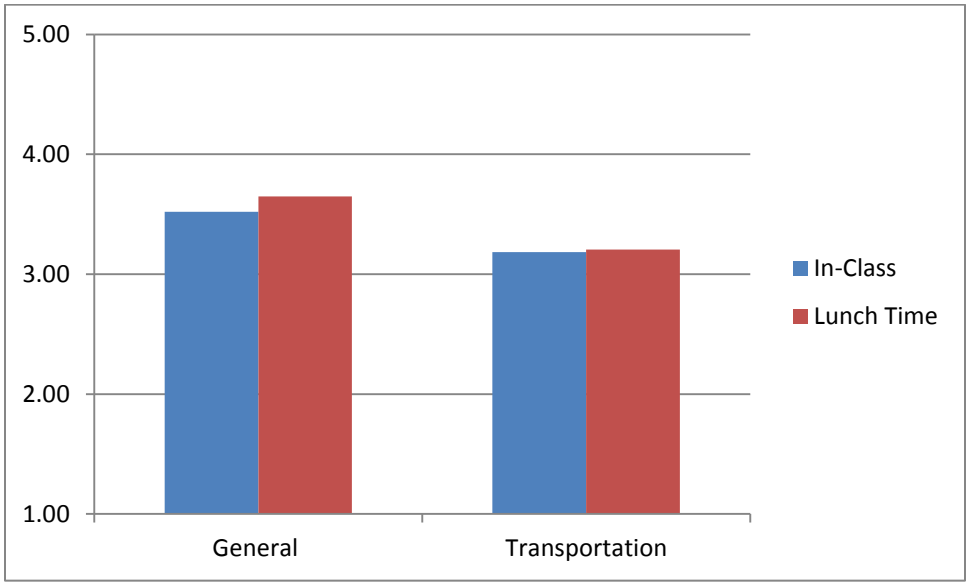


Figure 4.11 Environmental Attitudes by survey type



As shown in Figure 4.12, the in-class samples were more likely to be driven to/from school than the lunch time samples (27% compared to 18%). On the other hand, the lunch time samples were more likely to walk, take public transit and school bus to/from school (2 to 3% more for each travel mode). More samples from the in-class surveys are lower grades student; therefore more likely to be driven to/from school by their parents or older siblings. In terms of decision maker of the school trip, the samples collected in-class and lunch time have similar answers, with approximately 60% decided on their own (Figure 4.13).

In conclusion, the samples collected from the in-class survey have more female students and grade 8 students. There are no significant differences in environmental knowledge and attitudes between the samples collected from in-class time and lunch time. This is reasonable since there are no observable differences in environmental knowledge and attitudes by gender and grades. Lastly, the samples collected from the in-class survey were more likely to be driven to/from school.

Figure 4.12 Travel Mode to/from School by survey type

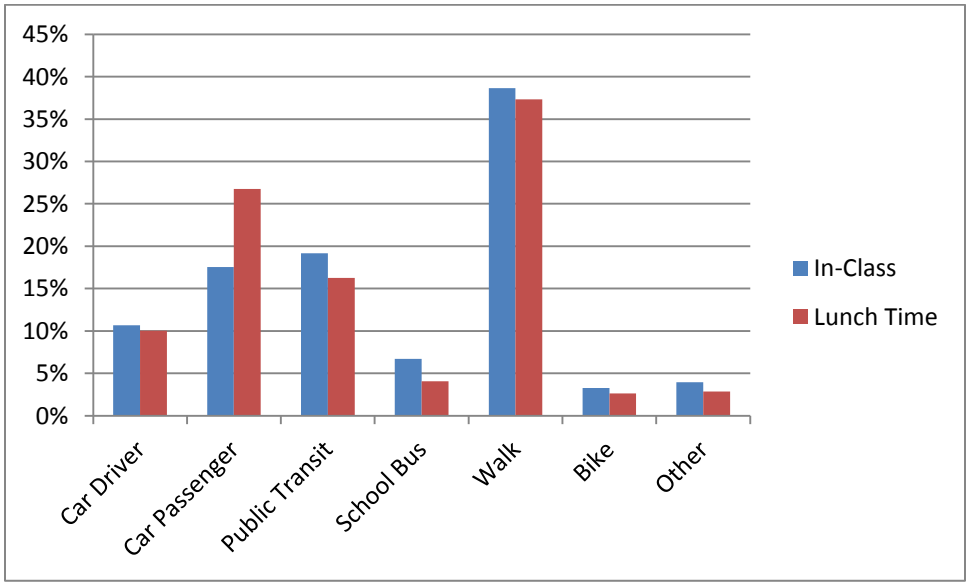
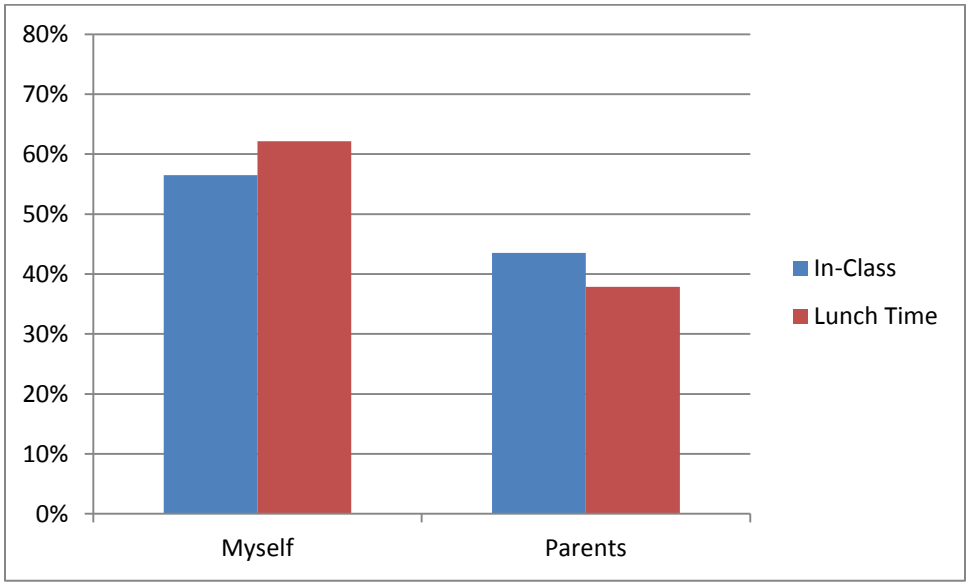


Figure 4.13 Decision Maker by survey type



5 The Impact of Environmental Knowledge on Environmental Attitudes

5.1 Introduction

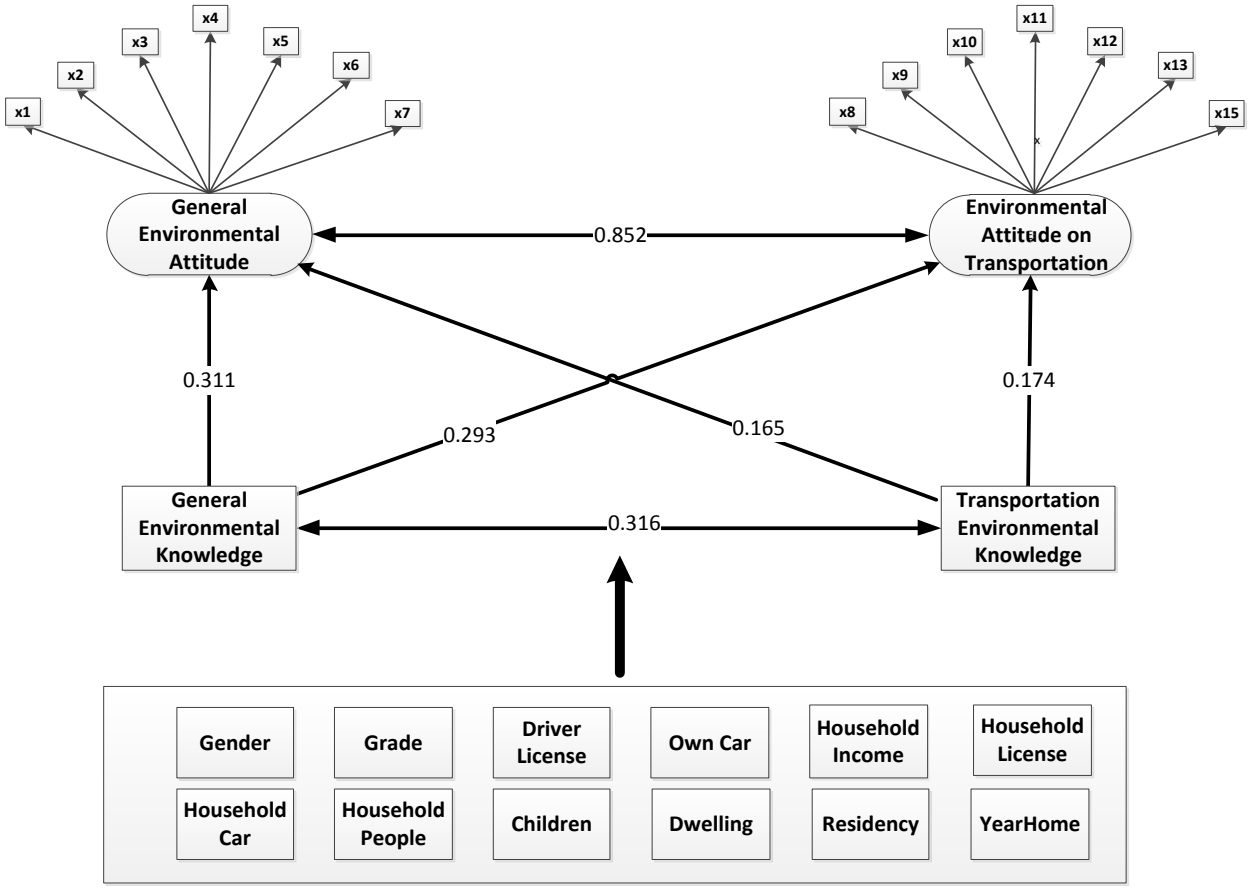
Childhood environmental education is generally considered the most beneficial; where early years of learning serve as a foundation for the formation of environmental attitudes. Many scholars have concluded that unless children develop a sense of respect and care for the environment during their early years, they are at risk of never developing such attitudes later in life (Stapp 1978; Tilbury 1994; Wilson 1994). Cohen (1984), for example, documented that if children develop negative attitudes toward the environment during their early years, such attitudes are likely to become deeply entrenched. While many studies have directly addressed the relationship between environmental knowledge and attitudes of youth (Ramsey and Rickson 1976; Jaus 1982; Mangas, Martinez et al. 1997; Bradley, Waliczek et al. 1999; Kuhlemeier, Bergh et al. 1999; Makki, Abd-El-Khalick et al. 2003; Negev, Sagy et al. 2008; He, Hong et al. 2011), no studies has focused on their environmental knowledge and attitudes specifically related to transportation.

5.2 Model Structures and Estimations

This chapter examines the impact of environmental knowledge on environmental attitudes in the context of both general and transportation issues using structural equation model. Figure 5.1 specifies the hypothesized relationships among the factors. The two environmental knowledge factors GENKNOW and TRANKNOW are assumed to affect the two attitude factors GENATT and TRANATT. GENKNOW and TRANKNOW are correlated with each other, as are GENATT and TRANATT. The model consists of three sets of equations: measurement equations that connect the latent variables to their corresponding indicators; structural equations that represent the relationship between knowledge factors and attitude factors; and structural equations that quantify the impact of demographic and socioeconomic variables on knowledge and attitudes.

Table 5.1 summarizes the overall goodness-of-fit statistics. Though CFI of 0.884 is slightly below 0.9, RMSEA and SRMR are below 0.05; in particular the full 90% confidence interval 0.039~0.046 falls below 0.05 so the overall data fit is acceptable. Table 5.2 shows the standardized factor loadings and t-statistics for the measurement equation for the two latent variables (GENATT and TRANATT). All measurement equations are significant at 1% level.

Figure 5.1 Specification of the Structural Equation Model



5.3 Model Results

Table 5.3 reports the estimated relationships between environmental knowledge and attitudes. All the relationships are significant and are in the expected direction. Students with better environmental knowledge hold higher levels of pro-environmental attitudes. Both general knowledge and transportation-specific knowledge contribute to stronger pro-environmental

attitudes. While general and transportation-specific attitudes are highly correlated (0.852), the correlation between general knowledge and transportation knowledge is significant but much weaker (0.316) in comparison.

Table 5.1 Goodness of Fit of Statistics for SEM

Overall Mode Fit	
Observations	937
Chi-Square	650.5
Degree of Freedom	269
CFI	0.884
TLI	0.845
RMSEA	0.037
90% CI of RMSEA	0.033~0.041
SRMR	0.036

Table 5.2 Measurement Equations for the Latent Variables

	Latent Factors			
	GENATT		TRANATT	
Measured by	Estimate	Est./S.E.	Estimate	Est./S.E.
x1	0.484	16.0	n.a.	
x4	0.441	13.9	n.a.	
x8	0.634	22.3	n.a.	
x11	0.444	14.1	n.a.	
x3	0.379	11.4	n.a.	
x14	0.591	19.2	n.a.	
x15	0.401	11.9	n.a.	
x6	n.a.		0.384	11.5
x7	n.a.		0.555	18.8
x10	n.a.		0.587	20.5
x13	n.a.		0.466	14.8
x2	n.a.		0.474	14.7
x5	n.a.		0.347	9.5
x12	n.a.		0.405	12.0

Table 5.3 Structural Equations between Environmental Knowledge and Attitudes

Independent	Dependent	Estimate	Est./S.E.
GENKNOW	GENATT	**0.308**	**8.2**
TRANKNOW	GENATT	**0.165**	**4.3**
GENKNOW	TRANATT	**0.288**	**7.2**
TRANKNOW	TRANATT	**0.174**	**4.3**
Correlation between GENATT and TRANATT		**0.851**	**22.8**
Correlation between GENKNOW and TRANKNOW		**0.317**	**10.5**

Note: Bold numbers are significant at 10% level.

Table 5.4 reports the estimated direct impact of the demographic and socioeconomic variables on environmental knowledge and attitudes. Six independent variables are significant to the attitudinal factors. Females have more positive general and transportation-specific environmental attitudes than male. This is in line with the Finland study reported by Tikka et al. (2000) that females tended to show more responsibility toward the environment than male. Household car ownership has a negative impact on both environmental attitudes. This is reasonable since students' households with more cars are more likely to travel by car and therefore the students' attitudes become less pro-environmental. Owning a personal vehicle has a negative impact on general environmental attitudes, but not on transportation-specific environmental attitudes. This is a bit surprising as owning a personal vehicle should be more likely to have an impact on transportation-specific attitudes than general attitudes. Dwelling type was treated as a series of dummy variables with house being the reference. Of the four dwelling types, only duplex turns out to be significant and have a negative impact on general environmental attitudes when compared with house. Grade level also has a negative impact on general environmental attitudes. However, as mentioned in Section 4.3, this study did not find the students' environmental attitudes increasing from grade to grade. Income was treated as dummy variables with medium income being the reference. Students in high-income households have more negative transportation-specific attitudes than students in medium income household. The significant impact of driver license status on GENATT, and number of

household driver licenses on TRANATT identified in ANOVA become insignificant after multiple independent variables are included.

Six independent variables are significant to the knowledge factors. In contrast to environmental attitudes, grade level has a positive impact on both general and transportation-specific environmental knowledge. This is expected as students in higher grades are expected to have better environmental knowledge. There is a positive correlation between general environmental knowledge and the number of years a youth is living in his/her current home. This is consistent with their significance in the bivariate ANOVA analysis. Household income was treated as dummy variables with medium income being the reference. Students in mid-income households are less knowledgeable on transportation-specific environmental issues than students in low and high income household.

On the other hand, three variables behave differently. Students owning a personal vehicle have a negative impact on both general and transportation-specific environmental knowledge. This is reasonable since these students have less environmental knowledge and might not realize the negative impacts in owning a vehicle. Similarly, students having a driver license have a negative impact on general environmental knowledge. Students living in high rises also have a negative impact on transportation-specific environmental knowledge compared to living in houses. This is unexpected as students living in a more compact urban setting are more likely to use sustainable transportation and therefore are expected to have better transportation-specific environmental knowledge.

Table 5.5 reported direct, indirect and total effects of the demographic and socioeconomic variables on GENATT and TRANATT via GENKNOW and TRANKNOW are significant at 10% level. Owning a personal vehicle has a negative indirect effect on both attitudes via environmental knowledge, while it has no direct effect on transportation-specific attitudes. Grade level and the number of years living at the current home show indirect effects on both attitudes via knowledge. Although grade level has a positive significant indirect impact on transportation-specific attitudes, it shows a significant negative direct impact on transportation-specific

attitudes which neutralizes the total effect. Living in high rises does not show significant direct effect, but it shows positive indirect effect on attitudes.

Table 5.4 Structural Equations for the Determinants of Environmental Knowledge and Attitudes

	Dependent Variables							
	GENATT		TRANATT		GENKNOW		TRANKNOW	
Independent Variables	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
MALE	**-0.072**	**-1.9**	**-0.091**	**-2.3**	0.031	0.9	-0.028	-0.8
GRADE	-0.038	-0.9	**-0.131**	**-2.8**	**0.146**	**3.8**	**0.070**	**1.8**
HOUSECAR	**-0.159**	**-3.3**	**-0.139**	**-2.8**	-0.047	-1.1	-0.012	-0.3
OWNCAR	**-0.151**	**-3.8**	-0.030	-0.7	**-0.102**	**-2.8**	**-0.074**	**-2.0**
HOUSEPPL	-0.054	-0.9	0.016	0.2	-0.019	-0.3	-0.060	-1.0
CHILDREN	0.001	0.0	0.025	0.4	0.003	0.1	-0.008	-0.2
HOUSELIC	0.076	1.4	-0.009	-0.2	-0.038	-0.8	0.020	0.4
DRILIC	-0.028	-0.5	-0.062	-1.2	**-0.097**	**-2.1**	0.012	0.3
YEARHOME	0.025	0.6	0.003	0.1	**0.138**	**3.9**	0.046	1.3
DUPLEX	**-0.088**	**-2.3**	-0.057	-1.4	0.053	1.5	-0.023	-0.6
TOWNHOUS	-0.052	-1.3	-0.063	-1.5	0.016	0.4	-0.054	-1.4
LOWRISE	0.011	0.3	-0.003	-0.1	0.016	0.4	-0.039	-1.0
HIGHRISE	-0.035	-0.9	-0.013	-0.3	-0.044	-1.2	**-0.092**	**-2.6**
RENT	-0.07	-1.6	-0.038	-0.8	0.018	0.5	0.027	0.7
LOWIN	-0.067	-0.9	-0.062	-0.8	-0.06	-0.9	**0.147**	**2.1**
HIGHIN	-0.079	-1.0	**-0.154**	**-1.9**	0.003	0.0	**0.166**	**2.3**

Note: Bold numbers are significant at 10% level

Table 5.5 Direct and Indirect Effects on General Environmental Attitudes and Transportation-Specific Environmental Attitudes

Explanatory Variables	Direct Effect		Total Indirect Effect		Total Effect	
	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
			GENATT			
Male	**-0.072**	**-1.9**	0.005	0.37	**-0.067**	**-1.72**
Grade	-0.038	-0.9	**0.057**	**3.46**	0.019	0.42
HouseCar	**-0.159**	**-3.3**	-0.016	-0.95	**-0.176**	**-3.51**
OwnCar	**-0.151**	**-3.8**	**-0.044**	**-2.96**	**-0.195**	**-4.69**
YearHome	0.025	0.6	**0.05**	**3.35**	**0.075**	**1.79**
Duplex	**-0.088**	**-2.3**	0.013	0.89	**-0.075**	**-1.84**
HighRise	-0.035	-0.9	**-0.029**	**-1.97**	-0.064	-1.54
			TRANATT			
Male	**-0.091**	**-2.31**	0.004	0.32	**-0.087**	**-2.10**
Grade	**-0.131**	**-2.83**	**0.054**	**3.37**	-0.077	-1.60
HouseCar	**-0.139**	**-2.75**	-0.016	-0.93	**-0.154**	**-2.93**
OwnCar	-0.03	-0.70	**-0.042**	**-2.92**	-0.072	-1.63
YearHome	0.003	0.07	**0.048**	**3.26**	0.051	1.15
HighRise	-0.013	-0.31	**-0.029**	**-2.02**	-0.042	-0.95
High Income	**-0.154**	**-1.91**	0.030	1.09	-0.124	-1.46

Note: Bold numbers are significant at 10% level.

Despite the significant relationships between environmental knowledge and attitudes, the r-square values of GENATT and TRANATT are only 0.263 and 0.235, respectively, suggesting that environmental knowledge, together with socioeconomic and demographic variables, can explain environmental attitudes only to a limited extent. To demonstrate environmental knowledge's capacity to explain environmental attitudes, two auxiliary SEMs (aux1 and aux 2) are estimated and their r-squares are compared to that in the main models in Table 5.6. The model with only demographic and socioeconomic variables as independent variables can explain a minimal amount of variation in GENATT and TRANATT (11.5% and 9.9%). Environmental knowledge, on the other hand, can explain 17.8% and 14.7% of the variation in GENATT and TRANATT, respectively.

An auxiliary model is developed to demonstrate the variation in knowledge and attitudes among students from different grades. This model treats GRADE as a series of dummy variables with Grade 8 being the reference. As mentioned in section 4.3, students' environmental

knowledge increased slightly and environmental attitudes did not increase from grade to grade. Table 5.7 confirms the earlier discussion after controlling for demographic and socioeconomic variables. For general environmental attitudes, there is no significant difference between grade 8 and the other grades. For transportation-specific attitudes, there is significant difference for grade 9 and 12 compared to grade 8. Overall, the impact of grade level on transportation-specific attitudes is non-linear.

Conversely, grade has a positive impact on both general and transportation-specific knowledge. There is significant increase in general knowledge for grade 10 to 12 students compared to grade 8 students, while there is only significant increase in transportation-specific knowledge for grade 12 students compared grade 8 students. This is logical because grade 12 students are of legal age to drive.

Table 5.6 Comparison of Explanatory Power between Models

Models	R-Square	
	GENATT	TRANATT
SEM aux 1: model with only demographic and socioeconomic variables	0.115	0.099
SEM aux 2: model with only environmental knowledge	0.178	0.147
SEM: main: model with demographic, socioeconomic variables and environmental knowledge	0.263	0.235

Table 5.7 Structural Equations for the Auxiliary Model

	Dependent Variables							
	GENATT		TRANATT		GENKNOW		TRANKNOW	
Independent Variables	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
GRADE 9	0.066	1.5	**0.084**	**1.8**	-0.012	-0.3	0.026	0.6
GRADE 10	0.038	0.8	0.040	0.8	**0.093**	**2.2**	0.026	0.6
GRADE 11	0.017	0.3	-0.052	-1.0	**0.112**	**2.5**	0.067	1.4
GRADE 12	-0.046	-0.8	**-0.153**	**-2.6**	**0.162**	**3.3**	**0.085**	**1.7**

Note: Bold numbers are significant at 10% level.

5.4 Summary

In summary, environmental knowledge is positively associated with pro-environmental attitudes. Students who have better knowledge of environmental issues also hold higher levels of pro-environmental attitudes, but the capacity of environmental knowledge to explain attitudes is limited. Environmental knowledge is an important determining factor of attitudes, but not a dominant one; many other factors also influence environmental attitudes. This suggests that knowledge should be emphasized in education in order to improve environmental attitudes, but the impact of environmental knowledge education alone should not be exaggerated.

The results have confirmed that grade level and car ownership status have significant impact on both general and transportation-specific environmental knowledge. Driver license status and the years living in current home have significant impact on general knowledge. Dwelling type and income level have significant impact on transportation-specific environmental knowledge. For example, students in higher grade levels have better environmental knowledge.

The results also found gender, household car ownership, personal car ownership, and dwelling type have significant impacts on general environmental attitudes. Gender, grade level, household car ownership, income level have significant impacts on transportation-specific environmental attitudes. For example, females are more environmental than males on both general and transportation-specific issues. Although grade level has a negative impact on transportation-specific attitudes, the impact is non-linear as demonstrated by the auxiliary model that treated GRADE as a series of dummy variables. In addition, grade level shows significant positive impact mediating through knowledge which neutralizes the total effect.

6 Disentangle Casual Direction between Environmental Attitudes and Travel Behavior

6.1 Introduction

The relationship between environmental attitudes and travel behavior has long been recognized in prior studies. However, there are competing hypotheses regarding the relationship between attitudes and behavior. Attitudes are formed through experiences as a result of behavior; on the contrary, attitudes prompt certain types of behavior. The task to tease out the exact causal direction between attitudes and behavior remains difficult. This study provides an opportunity to disentangle the direction of the mutual causalities.

In surveys, students were asked about their decision making process of commuting mode choices: whether the students make their own commuting decisions or if their parents make the decisions for them. For those whose parents make travel decisions, the causality between students' attitudes and their behavior cannot be realized. As a result, we can be more certain in making the assumption that it is their behavior that influences attitudes and not the other way around. Given the defined causal direction, the strength of such influence can be quantified using structural equation models after controlling demographic and socioeconomic variables. There is indeed a possibility that students' attitudes influence their parents' attitudes, which will in turn influence the parents' decision for the youth's travel choices; however, the causal path is more indirect and much weaker.

Even though the direction from behavior to attitudes is almost certain for the group where parents are decision makers, multiple group analysis is performed to compare the impact of behavior on attitudes between the two groups of students. Although the impact of behavior on attitudes cannot be determined exactly, the results from the following analysis explain the total combined effect of the mutual causalities. Parents who make travel decisions for students are denoted as PARENT-DECISION-MAKER, while students who make their own travel decisions are denoted as STUDENT-DECISION-MAKER.

This chapter begins with a comparison of the travel behavior between PARENT-DECISION-MAKER and STUDENT-DECISION-MAKER; followed by structural equation models results.

6.2 Comparison of Travel Behavior between PARENT-DECISION-MAKER and STUDENT-DECISION-MAKER

Students were asked to report their travel mode to/from school for the previous school day. As shown in Figure 6.1 and

Figure 6.2, students with parents as decision makers are more likely to be driven to/from school and are less likely to walk to school compared to students who make their own decision. The substantial differences between the two groups are likely due to parents' concern about safety and convenience and results in the preference to drive their children to school (DiGuiseppi, Roberts et al. 1998; McMillan 2003; Rhoulac 2005).

As mentioned in section 4.4, some students shifted from being car passengers in the morning to walking and taking public transit in the afternoon. The figure below shows a clearer picture that majority of students who travel as car passengers are those with parents as decision maker.

Figure 6.1 Comparison of Travel Mode to School

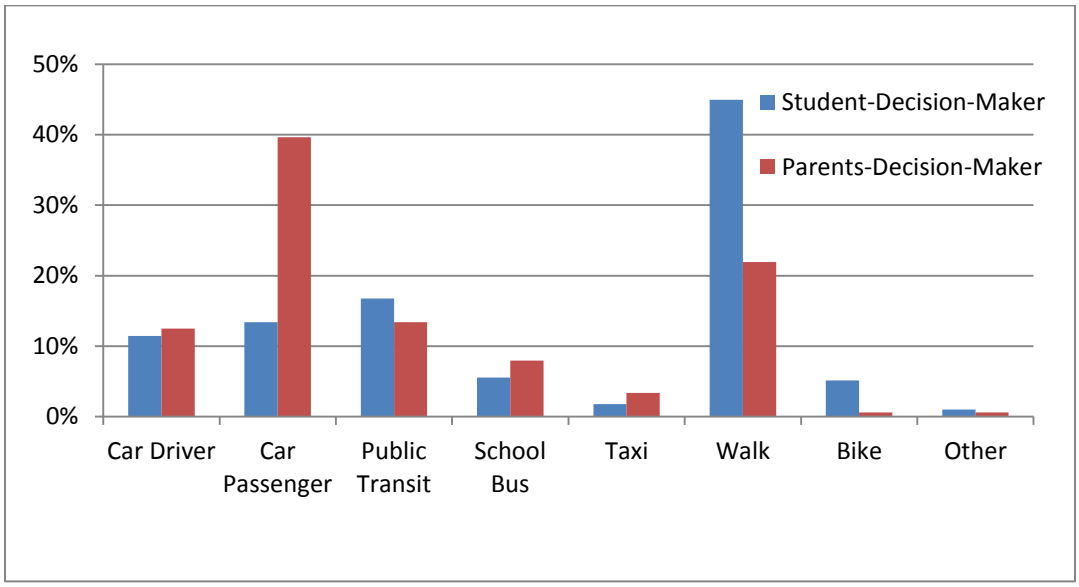
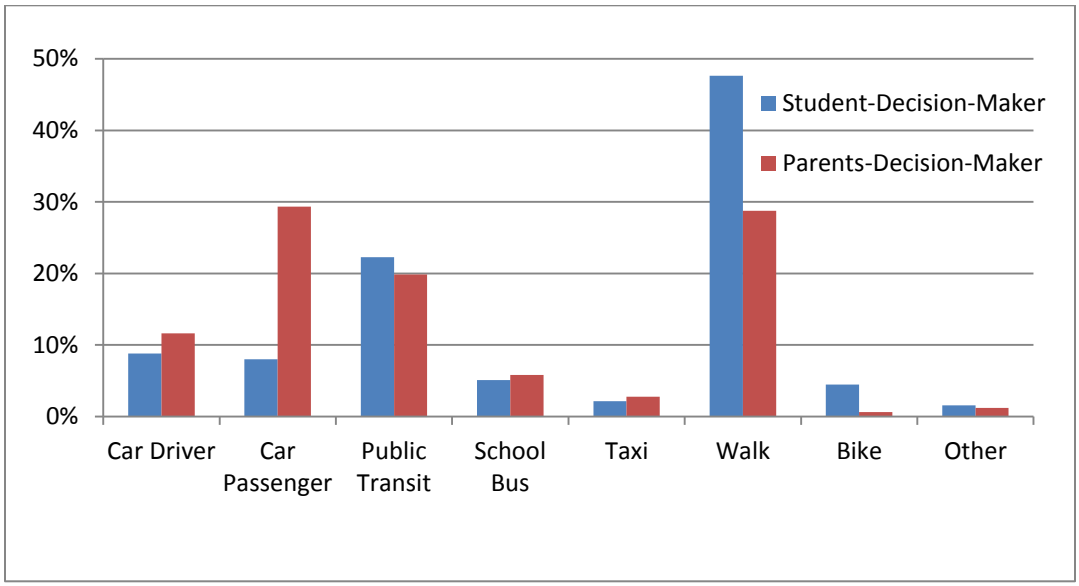


Figure 6.2 Comparison of Travel Mode from School



The frequency of transport modes utilized by parents and students as decision makers are reported in Table 6.1 and Table 6.2. Similar to travel mode to/from school, students with parents as decision makers are driven by car more frequently and walk less frequently compared to students who are decision makers.

Table 6.1 Frequent Use of Modes of Transport by STUDENT-DECISION-MAKER

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	once a fortnight	once a month	less often	never
Walk	51%	21%	10%	9%	3%	2%	2%	3%
Bike	4%	4%	6%	8%	4%	6%	28%	38%
Public Transit Buses	17%	13%	12%	19%	8%	8%	14%	10%
School Buses	1%	3%	1%	2%	1%	1%	6%	84%
Sky Train / Commuter Rail	6%	5%	12%	19%	10%	12%	19%	16%
Taxi	1%	1%	2%	4%	4%	4%	21%	64%
Car Driver	8%	4%	7%	9%	2%	2%	8%	60%
Car Passenger	21%	12%	22%	19%	5%	3%	7%	10%

Table 6.2 Percentages of Frequent Use of Modes of Transport by PARENT-DECISION-MAKER

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	once a fortnight	once a month	less often	never
Walk	31%	19%	15%	14%	4%	4%	7%	6%
Bike	2%	3%	4%	6%	6%	7%	28%	44%
Public Transit Buses	12%	13%	8%	13%	11%	11%	17%	16%
School Buses	2%	6%	2%	1%	1%	2%	7%	80%
Sky Train / Commuter Rail	5%	6%	5%	16%	15%	12%	21%	20%
Taxi	2%	1%	2%	2%	2%	3%	19%	69%
Car Driver	8%	5%	8%	5%	1%	1%	3%	69%
Car Passenger	47%	16%	11%	12%	2%	2%	1%	9%

The travel mode share by parents and students as decision makers are reported in Table 6.3. Mode share is calculated based on the frequent use of transport modes. The frequent use of transport modes is converted to the number of trips made for each mode. For example, walking 5 days a week equates to 10 trips. This assumes most people will likely utilize the same mode to and from their destination. Mode share is calculated by the number of trips for a particular mode divided by the total number of trips for all modes. Walk mode share is the highest for STUDENT-DECISION-MAKER and second highest for PARENT-DECISION-MAKER. On the other hand, car passenger mode share is the highest for PARENT-DECISION-MAKER and second highest for STUDENT-DECISION-MAKER.

Table 6.3 Comparison of Travel Mode Share

	Student-Decision-Maker	Parents-Decision-Maker
Walk	39%	28%
Bike	6%	3%
Public Transit Buses	16%	12%
School Buses	1%	3%
Sky Train / Commuter Rail	8%	6%
Taxi	1%	1%

Car Driver	7%	6%
Car Passenger	22%	41%

6.3 The Impact of Travel Behavior on Environmental Attitudes

Table 6.4 specifies the overall model structure for this chapter. Model a and b are based on multiple group analysis that compare the relationship between the two groups of students; whereas model c and d examine the students as a whole. In model a and c, environmental attitudes are treated as a single factor (ENVATT). In model b and d, environmental attitudes are separated into general attitudes (GENATT) and transportation-specific attitudes (TRANATT).

Table 6.4 Model Structure

Travel Behavior	Environmental Attitudes	STUDENT DECISION MAKER	PARENT DECISION MAKER	ALL
Travel Mode to School	ENVATT	1a		1c
	GENATT, TRANATT	1b		1d
Travel Mode from School	ENVATT	2a		2c
	GENATT, TRANATT	2b		2d
Travel Mode Frequency	ENVATT	3a		3c
	GENATT, TRANATT	3b		3d
Mode Share	ENVATT	4a		4c
	GENATT, TRANATT	4b		4d

In model a and c, travel behavior is assumed to affect ENVATT. In model b and d, travel behavior is assumed to affect the two attitude factors GENATT and TRANATT, and the correlations amongst GENATT and TRANATT. Three aspects of travel behavior are included in the analysis: travel mode to school, travel mode frequency and travel mode share.

The models consist of three sets of equations: measurement equations that connect latent variables to the indicators; structural equations that represent the relationships between attitude factor and travel behavior factors; and structural equations that quantify the impact of demographic and socioeconomic variables on attitude and travel behavior factors.

The definitions of the travel behavior factors are as follows:

SCHWB: Walk or bike to school
SCHCAR: Drive or being driven to school
SCHTB: Taking public transit or school bus to school
AFTWB: Walk or bike after school
AFTCAR: Drive or being driven after school
AFTTB: Taking public transit or school bus after school
WBFREQ: Frequency of walking and biking
TPFREQ: Frequency of using public transit buses and school buses
CARFREQ: Frequency of driving and travelling as car passenger
WBSHARE: Walking and biking mode share
TBSHARE: School bus and public transit buses mode share
CARSHARE: Car driver and car passenger mode share

The first series of models examine the impact of travel mode to school on environmental attitudes. Travel mode is treated as a series of dummy variables with SCHCAR being the reference. The two travel mode factors SCHWB and SCHTB were assumed to affect the attitude factors.

The second series of models examine the impact of travel mode from school on environmental attitudes. Travel mode is treated as a series of dummy variables with AFTCAR being the reference. The two travel mode factors AFTWB and AFTTB were assumed to affect the attitude factors.

The third series of models examine the impact of travel mode frequency on environmental attitudes. Students are asked to report the average use of eight different types of travel modes: walk, bike, public transit buses, school buses, SkyTrain/commuter rail, taxi, car driver and car passengers. In order to be consistent with the travel mode to/from school, SkyTrain/commuter rail and taxi are not included in this analysis. Three travel modes frequency factors (WBFREQ, TBFREQ, and CARFREQ) were assumed to affect the attitude factors.

The fourth series of models examines the impact of mode share on environmental attitudes. Mode share is calculated based on the frequency use of transport modes. The travel modes are grouped into three categories: active transportation, transit, and car. WBSHARE and TBSHARE were assumed to affect the attitude factors with CARSHARE being the reference.

Table 6.5 summarizes the overall goodness-of-fit statistics for models that examine the impact of travel behavior factors on environmental attitudes. The standardized factor loadings and the t-statistics for the measurement equation of the latent variables for model 1a and 1b are presented in Appendix C. All measurement equations are significant at 1% level.

Table 6.6 reports the estimated relationships between environmental attitudes and travel mode to school. In model 1a, where students' parents are decision makers, SCHWB and SCHTB have significant and positive impact compared to SCHCAR. In contrast, where students make their own decision, SCHWB and SCHTB have an insignificant impact on ENVATT. In model 1c, all the relationships are significant and are in the expected direction.

In model 1b, where students' parents are decision makers, all the relationships are significant except for SCHWB on GENATT. Students who take public transit or school bus have more positive general environmental than students who travel to school by car. However, there are no differences in general attitudes between the students who walk or bike to school and students who travel to school by car. On the other hand, students who walk or bike to school, and students who take public transit or school bus have more positive transportation-specific attitudes than students who travel to school by car. Again, for those students that are their own decision maker, SCHWB and SCHTB have an insignificant impact on GENATT and TRANATT. For both groups of students, GENATT and TRANATT are highly correlated. In model 1d, all the relationships are significant and in the expected directions.

Table 6.5 Goodness of Fit of Statistics – The Impact of Travel Behavior on Environmental Attitudes

	Goodness of Fit							
	Model 1a	**Model 1b**	**Model 1c**	**Model 1d**	**Model 2a**	**Model 2b**	**Model 2c**	**Model 2d**
Observations	812	812	886	886	812	812	886	886
Chi-Square	1214.8	1143	863.3	796.2	1391.9	1310.5	1012.5	935.6
Degree of Freedom	628	588	301	282	628	588	301	282
CFI	0.79	0.802	0.8	0.817	0.745	0.759	0.761	0.781
TLI	0.749	0.746	0.75	0.756	0.695	0.692	0.702	0.707
RMSEA	0.048	0.048	0.046	0.045	0.055	0.055	0.052	0.051
90% CI of RMSEA	0.044~0.052	0.044~0.052	0.042~0.050	0.042~0.049	0.051~0.059	0.051~0.059	0.048~0.055	0.048~0.055
SRMR	0.049	0.047	0.041	0.039	0.051	0.05	0.044	0.042
	Model 3a	**Model 3b**	**Model 3c**	**Model 3d**	**Model 4a**	**Model 4b**	**Model 4c**	**Model 4d**
Observations	858	858	937	937	854	854	933	933
Chi-Square	1377.8	1294.1	908.3	842.8	1181.2	1103.7	794.5	726.9
Degree of Freedom	760	712	367	344	628	588	301	282
CFI	0.813	0.824	0.832	0.845	0.809	0.822	0.83	0.847
TLI	0.749	0.748	0.766	0.77	0.772	0.773	0.787	0.795
RMSEA	0.044	0.044	0.04	0.039	0.045	0.045	0.042	0.041
90% CI of RMSEA	0.040~0.047	0.040~0.047	0.036~0.043	0.036~0.043	0.041~0.049	0.041~0.049	0.038~0.045	0.037~0.045
SRMR	0.047	0.045	0.038	0.036	0.049	0.047	0.04	0.038

Table 6.6 Structural Equations between Environmental Attitudes and Travel Mode to School

Model		1a				1c	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
SCHWB	ENVATT	0.066	1.1	**0.143**	**2.2**	**0.119**	**2.9**
SCHTB	ENVATT	0.053	0.9	**0.211**	**3.3**	**0.131**	**3.1**

Model		1b				1d	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
SCHWB	GENATT	0.046	0.7	0.099	1.4	**0.081**	**1.8**
SCHTB	GENATT	0.058	0.9	**0.187**	**2.7**	**0.118**	**2.6**
SCHWB	TRANATT	0.087	1.3	**0.178**	**2.6**	**0.151**	**3.3**
SCHTB	TRANATT	0.039	0.6	**0.219**	**3.1**	**0.131**	**2.8**
Correlation between GENATT and TRANATT		**0.910**	**21.2**	**0.843**	**15.0**	**0.880**	**26.8**

Note: Bold numbers are significant at 10% level.

Table 6.7 reports the direct, indirect and total effects of the demographic and socioeconomic variables on ENVATT via SCHWB and SCHTB that are significant at the 10% level. For the STUDENT-DECISION-MAKER group, male, household car ownership, ownership personal vehicle, living in duplex and renting the home have negative and direct impacts on ENVATT. No variables have an indirect effect on attitudes via travel mode to school. For the PARENT-DECISION-MAKER group, there is a negative and direct impact by males on ENVATT. On the other hand, living in high rises has positive and indirect impact on attitudes.

Table 6.7 Direct and Indirect Effects on Environmental Attitudes via Travel Mode to School

Explanatory Variables	Direct Effect		Total Indirect Effect		Total Effect	
	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
	ENVATT					
	Students					
Male	**-0.092**	**-1.9**	-0.001	-0.17	**-0.093**	**-1.87**
HouseCar	**-0.191**	**-2.9**	-0.005	-0.44	**-0.197**	**-3.08**
OwnCar	**-0.184**	**-3.3**	-0.014	-1.08	**-0.198**	**-3.65**
Driver License	-0.117	-1.6	-0.002	-0.25	**-0.119**	**-1.66**
Duplex	**-0.116**	**-2.3**	-0.005	-0.83	**-0.122**	**-2.38**
Rent	**-0.109**	**-1.9**	-0.001	-0.29	**-0.11**	**-1.90**
	Parents					
Male	**-0.106**	**-1.76**	0.011	0.72	-0.095	-1.54
Highrise	-0.107	-1.61	**0.031**	**1.73**	-0.075	-1.11

Note: Bold numbers are significant at 10% level.

Table 6.8 reports the estimated relationships between environmental attitudes and travel mode from school. The models' results are similar to the impact of travel mode to school on environmental attitudes; with the exception that AFTWB and AFTTB have significant and positive impacts on TRANATT compared to AFTCAR for those students that made their own commuting decisions. This suggests the mode choice for after school trips for those students have a more significant impact on transportation-specific environmental attitudes than morning trips.

Table 6.10 reports the estimated relationships between environmental attitudes and travel mode frequency. In model 3a, CARFREQ has a significant impact on ENVATT for both PARENT-DECISION-MAKER and STUDENT-DECISION-MAKER. This suggests that students who travel by car more frequently, their attitudes are likely to become less pro-environmental. In model 3c, WBFREQ and CARFREQ both have significant impacts on ENVATT. Students who walk more have higher levels of pro-environmental attitudes, and students who travel by car more have lower levels of pro-environmental attitudes.

Table 6.9 reports direct, indirect and total effects of the demographic and socioeconomic variables on ENVATT via AFTWB and AFTTB that are significant at the 10% level. The results are similar with the impact on ENVATT via SCHWB and SCHTB.

Table 6.8 Structural Equations between Environmental Attitudes and Travel Mode from School

Model		2a				2c	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
AFTWB	ENVATT	0.104	1.5	**0.208**	**3.2**	**0.167**	**3.7**
AFTTB	ENVATT	0.075	1.1	**0.277**	**4.3**	**0.185**	**4.1**

Model		2b				2d	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
AFTWB	GENATT	0.008	0.1	0.144	2.0	**0.082**	**1.6**
AFTTB	GENATT	0.009	0.1	**0.233**	**3.2**	**0.136**	**2.7**
AFTWB	TRANATT	**0.214**	**2.9**	**0.255**	**3.7**	**0.243**	**5.2**
AFTTB	TRANATT	**0.147**	**2.0**	**0.300**	**4.4**	**0.218**	**4.6**
Correlation between GENATT and TRANATT		**0.917**	**21.7**	**0.843**	**14.7**	**0.885**	**26.9**

Note: Bold numbers are significant at 10% level.

Table 6.10 reports the estimated relationships between environmental attitudes and travel mode frequency. In model 3a, CARFREQ has a significant impact on ENVATT for both PARENT-DECISION-MAKER and STUDENT-DECISION-MAKER. This suggests that students who travel by car more frequently, their attitudes are likely to become less pro-environmental. In model 3c, WBFREQ and CARFREQ both have significant impacts on ENVATT. Students who walk more

have higher levels of pro-environmental attitudes, and students who travel by car more have lower levels of pro-environmental attitudes.

Table 6.9 Direct and Indirect Effects on Environmental Attitudes via Travel Mode after School

Explanatory Variables	Direct Effect		Total Indirect Effect		Total Effect	
	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
	ENVATT					
	Students					
Male	**-0.090**	**-1.8**	-0.002	-0.29	**-0.092**	**-1.84**
HouseCar	**-0.194**	**-3.0**	-0.004	-0.37	**-0.199**	**-3.10**
OwnCar	**-0.176**	**-3.1**	-0.023	-1.37	**-0.199**	**-3.67**
Duplex	**-0.116**	**2.3**	-0.001	-0.26	**-0.117**	**2.28**
Rent	**-0.105**	**-1.8**	-0.006	-0.80	**-0.111**	**-1.92**
	Parents					
Male	**-0.109**	**-1.87**	0.015	0.76	-0.094	-1.53
Grade	**-0.111**	**-1.59**	0.05	2.00	-0.061	-0.84
HouseCar	-0.026	-0.32	**-0.053**	**-1.84**	-0.079	-0.94
HouseLic	0.011	0.11	**-0.059**	**-1.77**	-0.048	-0.49

Note: Bold numbers are significant at 10% level.

In model 3b, for students whose parents are decision makers, DRIVEFREQ has a significant and negative impact on GENATT and TRANATT. However, WALKFREQ has significant and positive impact on GENATT and not on TRANATT. For those students who make their own decision, BIKEFREQ has significant and positive impact on GENATT and TRANATT, and BUSFREQ and DRIVEFEQ have significant and negative impacts on GENATT and TRANATT. In model 3d, WALKFREQ, TRANFREQ have significant and positive impact on GENATT and TRANATT, and DRIVEFREQ has a significant and negative impact on GENATT and TRANATT. BIKEFREQ has significant and positive impact on TRANATT and not on GENATT. Similarly, PASSFREQ has significant and negative impact on TRANATT and not on GENATT. For both model 3b and 3d, GENATT and TRANATT are highly correlated.

Table 6.10 Structural Equations between Environmental Attitudes and Travel Mode Frequency

Model		3a				3c	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
WBFREQ	ENVATT	0.075	1.5	0.044	0.6	**0.066**	**1.7**
TBFREQ	ENVATT	0.022	0.4	0.063	1.0	0.041	1.0
CARFREQ	ENVATT	**-0.169**	**-3.2**	**-0.151**	**-2.4**	**-0.165**	**-4.1**

Model		3b				3d	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
WBFREQ	GENATT	0.038	0.7	0.039	0.5	0.041	1.0
TBFREQ	GENATT	0.012	0.2	0.082	1.2	0.051	1.2
CARFREQ	GENATT	-0.140	-2.5	**-0.131**	**-2.0**	**-0.124**	**-2.9**
WBFREQ	TRANATT	**0.121**	**2.2**	0.04	0.5	**0.091**	**2.1**
TBFREQ	TRANATT	0.030	0.5	0.029	0.4	0.02	0.5
CARFREQ	TRANATT	**-0.201**	**-3.3**	-0.16	**-2.2**	-0.206	-4.5
Correlation between GENATT and TRANATT		**0.904**	**20.0**	**0.865**	**16.4**	**0.877**	**26.4**

Note: Bold numbers are significant at 10% level.

Table 6.11 reports the direct, indirect and total effects of the demographic and socioeconomic variables on ENVATT that are significant at the 10% level. For STUDENT-DECISION-MAKER group, male, household car ownership, ownership personal vehicle, and living in duplex have negative and direct impacts on ENVATT. Household car ownership, ownership personal vehicle, living in duplex and renting the home have negative indirect impacts on ENVATT via travel mode frequency factors. For PARENT-DECISION-MAKER group, male and high rises have negative and direct impacts on ENVATT; household car ownership and driving license status have negative and indirect impacts on ENVATT via travel mode frequency factors.

Table 6.11 Direct and Indirect Effects on ENVATT via Travel Mode Frequency

Explanatory Variables	Direct Effect		Total Indirect Effect		Total Effect	
	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
	ENVATT					
	Students					
Male	**-0.095**	**-2.0**	0.017	1.2	-0.078	-1.6
HouseCar	**-0.115**	**-1.8**	**-0.060**	**-2.5**	**-0.174**	**-2.9**
OwnCar	**-0.123**	**-2.1**	**-0.077**	**-2.88**	**-0.200**	**-3.8**
Duplex	**-0.121**	**-2.4**	**-0.024**	**-1.74**	**-0.145**	**-2.9**
Rent	-0.083	-1.5	**-0.025**	**-1.69**	**-0.108**	**-1.9**
	Parents					
Male	**-0.102**	**-1.8**	-0.010	0.6	-0.092	-1.6
HouseCar	-0.063	-0.8	**-0.068**	**-2.3**	**-0.131**	**-1.7**
Drive License	0.014	0.2	**-0.053**	**-2.1**	-0.039	-0.5
Highrise	**-0.177**	**-2.7**	0.013	0.5	**-0.164**	**-2.7**

Note: Bold numbers are significant at 10% level.

Table 6.12 reports the estimated relationships between environmental attitudes and mode share. In model 4a, for both groups of students, WBSHARE and TBSHARE have significant and positive impacts on ENVATT compared to CARSHARE. The same result is found in model 4c when the students are examined as a whole.

In model 4b, for PARENT-DECISION-MAKER, all the relationships are significant except for WBSHARE on GENATT. Students who use public transportation have more positive general environmental attitudes than students who travel to school by car, but there are no differences in general attitudes between the students who walk or bike to school and students who travel to school by car. On the other hand, students who walk or bike to school, and students who take public transit or school bus have more positive transportation-specific attitudes than students who travel to school by car. For STUDENT-DECISION-MAKER, WBSHARE and TBSHARE have significant impacts on both GENATT and TRANATT. For both groups of students, GENATT and TRANATT are highly correlated. The same result is found in model 4d when the students are examined as a whole.

Table 6.12 Structural Equations between Environmental Attitudes and Mode Share

Model		4a				4c	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
WBSHARE	ENVATT	**0.223**	**3.9**	**0.119**	**1.8**	**0.186**	**4.5**
TBSHARE	ENVATT	**0.176**	**3.0**	**0.165**	**2.5**	**0.162**	**3.8**

Model		4b				4d	
Decision Maker		Students		Parents		All	
Independent	Dependent	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
WBSHARE	GENATT	**0.147**	**2.4**	0.098	1.4	**0.123**	**2.7**
TBSHARE	GENATT	**0.126**	**2.0**	**0.162**	**2.3**	**0.131**	**2.8**
WBSHARE	TRANATT	**0.320**	**5.3**	**0.125**	**1.7**	**0.249**	**5.5**
TBSHARE	TRANATT	**0.234**	**3.7**	**0.154**	**2.1**	**0.184**	**4.0**
Correlation between GENATT and TRANATT		**0.912**	**19.8**	**0.86**	**16.2**	**0.879**	**26.3**

Note: Bold numbers are significant at 10% level.

Table 6.13 reports the direct, indirect and total effects of the demographic and socioeconomic variables on ENVATT that are significant at the 10% level. For the STUDENT-DECISION-MAKER group, male, household car ownership, ownership personal vehicle, years of living in current home, duplex and rent have negative and direct impacts on ENVATT. Household car ownership and ownership personal vehicle have negative indirect impacts on ENVATT via mode share factors. For the PARENT-DECISION-MAKER group, only male and high rises have negative and direct impacts on ENVATT.

Table 6.13 Direct and Indirect Effects on Environmental Attitudes via Travel Mode Frequency

Explanatory Variables	Direct Effect		Total Indirect Effect		Total Effect	
	Estimate	Est./S.E.	Estimate	Est./S.E.	Estimate	Est./S.E.
	ENVATT					
	Students					
Male	**-0.089**	**-1.9**	0.015	1.1	-0.074	-1.5
HouseCar	**-0.119**	**-2.0**	-0.052	-2.5	**-0.171**	**-2.8**
OwnCar	**-0.142**	**-2.6**	**-0.053**	**-2.6**	**-0.195**	**-3.7**
YearHome	0.084	1.6	**-0.027**	**-1.7**	0.057	1.1
Duplex	**-0.129**	**-2.6**	-0.013	-0.9	**-0.142**	**-2.8**
Rent	**-0.093**	**-1.7**	-0.011	-0.7	**-0.104**	**-1.9**
	Parents					
Male	**-0.104**	**-1.8**	0.015	1.1	-0.089	-1.5
Highrise	**-0.189**	**-3.1**	0.029	1.8	**-0.159**	**-2.6**

Note: Bold numbers are significant at 10% level.

6.4 Summary

In summary, travel behavior has a statistically significant impact on environmental attitudes for students whose parents made commuting decisions on their behalf. Four main findings emerge. First, students who walk or bike to school, and students who take public transit or school bus have higher levels of pro-environmental attitudes than students who travel to school by car. Second, students who drive more frequently are more likely to have lower levels of pro-environmental attitudes. Third, walking and biking mode share and public transit and school bus mode share have significant and positive impacts on environmental attitudes compared to car mode share. Lastly, general environmental attitudes and transportation-specific environmental attitudes are highly correlated. Therefore, there are similar impacts of travel behavior on both attitudes.

Since there are mutual causalities between behavior and attitudes for those students who make their own commuting decisions instead of one-way impact from behavior to attitudes, the model results can only suggest the combined effect of the mutual causality between the two factors.

Despite the significant relationships between travel behaviors and environmental attitudes, the explanatory power for ENVATT are less than 21% for the three main models, suggesting that travel behavior, together with socioeconomic and demographic variables, can explain environmental attitudes only to a limited extent.

7 The Relationship between Environmental Knowledge, Attitudes and Travel Behavior

7.1 Introduction

As mentioned in the literature review, few studies have explored the relationship between environmental knowledge, attitudes and travel behavior. In particular, none of the previous studies have focused on youth. In this chapter, the relationship between environmental knowledge, attitudes and travel behavior of youth is explored. There are three hypotheses on the relationships among these three factors.

Hypothesis 1: Environmental attitude is a mediating variable or mediator of environmental knowledge's effect on travel behavior (Figure 7.3). Environmental knowledge significantly affects environmental attitudes; environmental attitudes have a significant effect on travel behavior; environmental knowledge affects travel behavior in the absence of environmental attitudes; and the effect of environmental knowledge on travel behavior is diminished to be non-significant with environmental attitudes added to the relationship.

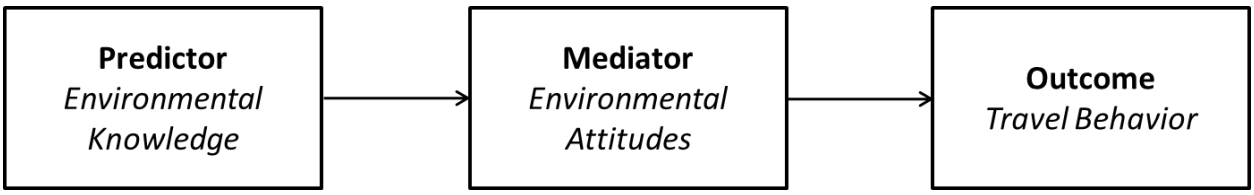


Figure 7.1 The Mediating Effect of Environmental Attitudes on the Relationship between Environmental Knowledge and Travel Behavior

Hypothesis 2: Environmental knowledge is a confounding variable or confounder of environmental attitudes' effect on travel behavior (Figure 7.1). Environmental knowledge is associated with travel behavior, varies over the level of environmental attitudes (with relationship both ways), and is not a cause of travel behavior.

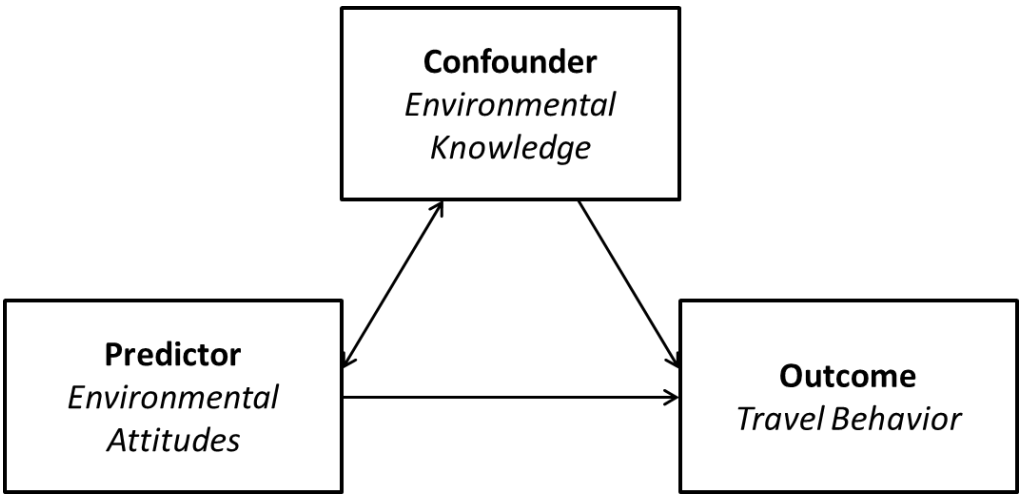


Figure 7.2 The Confounding Effect of Environmental Knowledge on the Relationship between Environmental Attitudes and Travel Behavior

Hypothesis 3: Environmental knowledge is a moderating variable or effect modifier. The magnitude of environmental knowledge affects the magnitude or direction of environmental attitudes' effect on travel behavior (Figure 7.2).

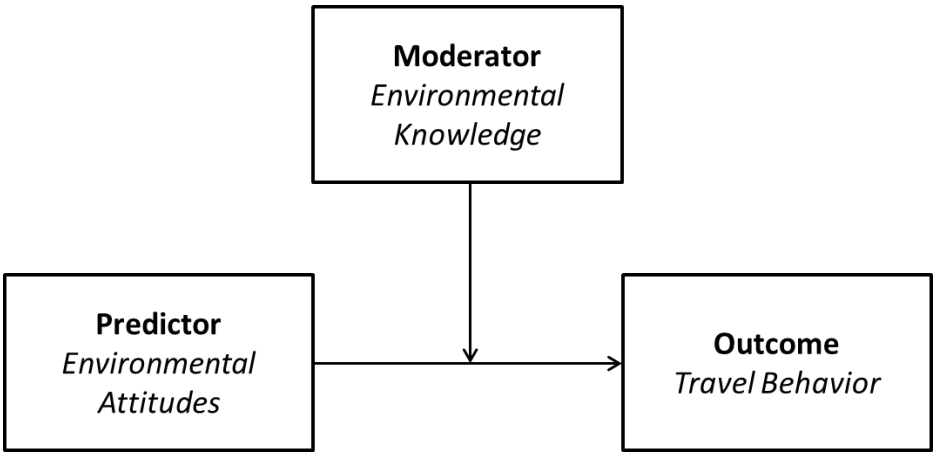


Figure 7.3 The Moderating Effect of Environmental Knowledge on the Relationship between Environmental Attitudes and Travel Behavior

For each of the proposed relationship, environmental knowledge (ENVKNOW), environmental attitudes (ENVATT) and four aspects of travel behavior (travel mode to school, travel mode

from school, travel mode frequency and travel mode share) are included in the analysis. The definition of travel behavior factors have been previously described in Chapter 6.

7.2 The Mediating Effect of Environmental Attitudes on the Relationship between Environmental Knowledge and Travel Behavior

This section examines the mediating effect of environmental attitudes on the relationship between environmental knowledge and travel behavior. Environmental knowledge is assumed to affect environmental attitudes, which in turn are assumed to affect travel behavior.

Table 7.1 summarizes the overall goodness-of-fit statistics for the models. All measurement equations are significant at the 1% level.

Table 7.1 Goodness of Fit of Statistics –Environmental Attitudes as Mediating Variable

	Goodness of Fit			
	Model 1	**Model 2**	**Model 3**	**Model 4**
	Travel Mode to School	**Travel Mode from School**	**Travel Mode Frequency**	**Mode Share**
Observations	886	886	933	933
Chi-Square	692.84	698.911	749.74	724.946
Degree of Freedom	315	315	329	315
CFI	0.872	0.878	0.863	0.867
TLI	0.835	0.841	0.817	0.828
RMSEA	0.037	0.037	0.037	0.037
90% CI of RMSEA	0.033~0.041	0.033~0.041	0.033~0.041	0.033~0.041
SRMR	0.036	0.036	0.037	0.037

Table 7.2 reports the estimated relationships between environmental knowledge, environmental attitudes and travel behavior. In all the models, environmental knowledge has significant and positive impacts on environmental attitudes. In model 1 and model 2, environmental attitudes have a more significant and positive impacts on travel to/from school by active transportation and transit in comparison to car. In model 3, environmental attitudes have significant and a positive impact on travel mode frequency by active transportation, and a negative impact on travel mode frequency by car. On the other hand, environmental attitudes

have an insignificant impact on travel mode frequency by transit. In model 4, environmental attitudes have a significant and positive impact on active transportation and transit mode share. This suggests that students who have better knowledge of environmental issues hold higher levels of pro-environmental attitudes. Students with pro-environmental attitudes are more likely to use active transportation but not transit.

Four auxiliary SEMs are estimated to demonstrate the direct impact of environmental knowledge on travel behavior factors when environmental attitude is no longer a mediating variable between environmental knowledge and travel behavior factors. ENVKNOW has a significant impact on AFTTB, but not on AFTCAR. Overall, the model results suggest that environmental knowledge do not have a significant impact on travel behavior factors directly.

Table 7.2 Structural Equations – Environmental Attitudes as Mediating Variable

Model	Independent	Dependent	Estimate	Est./S.E.
1	ENVKNOW	ENVATT	**0.388**	**11.7**
	ENVATT	SCHTB	**0.078**	**2.0**
	ENVATT	SCHWB	**0.069**	**1.7**
2	ENVKNOW	ENVATT	**0.390**	**11.7**
	ENVATT	AFTTB	**0.090**	**2.2**
	ENVATT	AFTWB	**0.074**	**1.8**
3	ENVKNOW	ENVATT	**0.396**	**12.2**
	ENVATT	FREQWB	**0.082**	**2.0**
	ENVATT	FREQTB	0.044	1.1
	ENVATT	FREQCAR	**-0.16**	**-4.2**
4	ENVKNOW	ENVATT	**0.396**	**12.2**
	ENVATT	WBSHAR	**0.125**	**3.0**
	ENVATT	TBSHAR	**0.090**	**2.2**

7.3 The Confounding Effect of Environmental Knowledge on the Relationship between Environmental Attitudes and Travel Behavior

This section examines the confounding effect of environmental knowledge on the relationship between environmental attitudes and travel behavior. Environmental knowledge and attitudes are assumed to affect travel behavior; environmental knowledge and attitudes are assumed to affect each other.

Table 7.3 summarizes the overall goodness-of-fit statistics for models. All measurement equations are significant at the 1% level.

Table 7.3 Goodness of Fit of statistics –Environmental Knowledge as Confounding Variable

	Goodness of Fit			
	Model 1	**Model 2**	**Model 3**	**Model 4**
	Travel Mode to School	**Travel Mode from School**	**Travel Mode Frequency**	**Mode Share**
Observations	886	886	933	933
Chi-Square	692.201	695.924	741.186	721.299
Degree of Freedom	313	313	326	313
CFI	0.872	0.878	0.865	0.867
TLI	0.833	0.841	0.817	0.827
RMSEA	0.037	0.037	0.037	0.037
90% CI of RMSEA	0.033~0.041	0.033~0.041	0.033~0.040	0.034~0.041
SRMR	0.036	0.036	0.036	0.037

Table 7.4 reports the estimated relationships between environmental knowledge, environmental attitudes and travel behavior. In all models, environmental knowledge and environmental attitudes are strongly related. However, only two models have found a significant impact of environmental knowledge and attitudes on travel behavior. In model 1 and 2, environmental knowledge and attitudes do not have a significant impact on travel mode to/from school. In model 3, environmental attitude has a significant impact on travel mode frequency and in the expected direction. However, environmental knowledge has a negative

impact on FREQWB, and an insignificant impact on FREQTB and FREQCAR. In model 4, environmental attitude has a significant impact on travel mode share. Environmental knowledge also has a significant negative impact on active transportation mode share and an insignificant impact on transit mode share in comparison to car mode share. Overall, the model results suggest that environmental knowledge does not have a significant impact on the relationship of environmental attitudes and travel behavior.

Table 7.4 Structural Equations – Environmental Knowledge as Confounding Variable

Model	Independent	Dependent	Estimate	Est./S.E.
1	ENVKNOW	SCHTB	0.022	0.5
	ENVKNOW	SCHWB	0.010	0.3
	ENVATT	SCHTB	0.067	1.5
	ENVATT	SCHWB	0.064	1.4
	Correlation between ENVKNOW and ENVATT		**0.399**	**11.8**
2	ENVKNOW	AFTTB	0.035	0.9
	ENVKNOW	AFTWB	0.026	0.7
	ENVATT	AFTTB	0.071	1.6
	ENVATT	AFTWB	0.06	1.3
	Correlation between ENVKNOW and ENVATT		**0.399**	**11.8**
3	ENVKNOW	FREQWB	**-0.112**	**-2.7**
	ENVKNOW	FREQTB	-0.069	-1.6
	ENVKNOW	FREQCAR	0.017	0.4
	ENVATT	FREQWB	**0.141**	**3.1**
	ENVATT	FREQTB	**0.081**	**1.7**
	ENVATT	FREQCAR	**-0.168**	**-3.9**
	Correlation between ENVKNOW and ENVATT		**0.408**	**12.5**
4	ENVKNOW	WBSHAR	**-0.076**	**-1.7**
	ENVKNOW	TBSHAR	-0.005	-0.1
	ENVATT	WBSHAR	**0.165**	**3.5**
	ENVATT	TBSHAR	**0.093**	**2.0**
	Correlation between ENVKNOW and ENVATT		**0.408**	**12.5**

7.4 The Moderating Effect of Environmental Knowledge on the Relationship between Environmental Attitudes and Travel Behavior

Multiple group analyses are performed to examine the relationship between attitudes and behavior for three different levels of knowledge. As mentioned in chapter 4, the total score for the environmental knowledge questions is fourteen. The definitions of the environmental knowledge levels are shown in Table 7.5.

Table 7.5 Environmental Knowledge Levels

Level of Knowledge	Scores	# of Samples
Low (KNOWLOW)	0-4	261
Medium (KNOWMED)	5-9	249
High (KNOWHIGH)	10-14	407

The moderating effect of environmental knowledge on the relationship between environmental attitudes and the four travel behavior variables (travel mode to school, travel mode from school, travel mode frequency and travel mode share) are tested using four models. The results are summarized in Table 7.6, which shows the standardized coefficients (t-statistics in parenthesis).

Environmental attitudes have a significant impact on travel mode to school (active transportation in comparison to by car) for students that have low and medium levels of environmental knowledge. In contrast, an insignificant relationship is found for students that have high level of environmental knowledge. Similar results are found for travel mode from school, travel mode frequency and travel mode share. The results suggest environmental knowledge moderates the relationship between environmental attitudes and travel by active transportation in comparison to car. However, environmental knowledge does not moderate the relationship between environmental attitudes and travel by transit in comparison to car.

Table 7.6 Structural Equations – Environmental Knowledge as Moderating Variable

	Environmental Attitudes and Travel Mode to/from School			
	SCHWB	SCHTB	AFTWB	AFTTB
KNOWLOW	**0.216 (2.5)**	0.084 (1.0)	**0.168 (1.7)**	0.124 (1.3)
KNOWMED	**0.188 (2.2)**	0.049 (0.6)	**0.168 (1.9)**	0.027 (0.3)
KNOWHIGH	-0.038 (-0.6)	0.079 (1.3)	-0.011 (-0.2)	0.063 (1.0)
	Environmental Attitudes and Travel Mode Frequency			
	FREQWB	FREQTB	FREQCAR	
KNOWLOW	**0.187 (2.1)**	0.001 (0.0)	-0.224 (-2.5)	
KNOWMED	**0.315 (3.7)**	0.033 (0.4)	**-0.155 (-1.9)**	
KNOWHIGH	-0.006 (-0.1)	0.091 (1.4)	-0.071 (-1.2)	
	Environmental Attitudes and Travel Mode Share			
	WBSHAR	TPSHAR		
KNOWLOW	**0.342 (3.6)**	0.031 (0.3)		
KNOWMED	**0.344 (3.9)**	-0.052 (-0.6)		
KNOWHIGH	-0.058 (-0.9)	**0.134 (2.1)**		

*The significant relationships are in bold

7.5 Summary

This chapter has examined the three types of relationships among environmental knowledge, attitudes and travel behavior. There are three major findings that emerge from the analysis. First, while environmental knowledge does not have a direct impact on travel behavior, environmental attitude is found to be a mediating variable between environmental knowledge and travel behavior. Second, environmental knowledge is not a confounder of the effect of environmental attitudes on travel behavior. Lastly, environmental knowledge moderates the relationship between environmental attitudes and travel by active transportation.

8 Environmental Education Program and Policies

This chapter explores the environmental education program and policies in British Columbia and seeks to answer three principal questions: 1) What is the current status of environmental education in British Columbia and how might it be improved? 2) What is the role of environmental education on transportation? 3) What are the sources of environmental information for students?

These questions are answered through review of the environmental education curriculum of British Columbia, interviews with teachers, representatives from the school board and transportation authority, as well as students' survey results.

8.1 Environmental Education Curriculum in British Columbia

In June of 1992, at the United Nations Conference on Environment and Development held in Rio de Janeiro, Canada signed the Agenda 21 agreement, which included obligations to promote education, public awareness and training on environment and sustainable development. Several objectives were outlined including the achievement of environmental and development awareness in all sectors of society on a world-wide scale. This objective is meant to be realized through the accessibility of environmental and development education, linked to social education, from primary school age through adulthood to all groups of people. Advancing environmental education within the mainstream education system and curriculum is seen as a key to long-term success.

Under the Constitution, formal education falls within provincial and territorial jurisdiction, including the setting of the educational curriculum. Curriculum policy directs what is taught in schools and affects resource allocation, teacher training and the development of textbooks and other materials. While direct federal involvement in formal environmental education is limited by its lack of constitutional authority for education, Environment Canada is collaborating actively with other federal departments, such as Natural Resources Canada, Parks Canada, and Fisheries and Oceans Canada, to steward Canada's response to the UN Decade of Education for

Sustainable Development (2005 - 2014) and with helping to move forward education for sustainable development in Canada.

At the provincial/territorial level, approaches to curriculum policy and environmental education vary greatly. Most, if not all, provincial/territorial curricula include either goals or language relating to environmental education. However, almost all provinces/territories lack a coordinated approach to the development and advancement of environmental education. In British Columbia, the Ministry of Education developed the Integrated Resource Packages (IRPs) which are applicable to all public schools in the province. The IRPs are essentially the curriculum that is to be covered in the classroom and are split up into grade levels and subjects. There are four sections within each of the IRPs: Prescribed Learning Outcomes (PLOs), Suggested Instructional Strategies (SIS), Suggested Assessment Strategies, and Recommended Learning Resources. The Prescribed Learning Outcomes outline the topics to be covered in the classroom. It is the only portion of the IRPs that have to be strictly followed. Suggested Instructional Strategies are suggested methods for the teachers to achieve the PLOs. Assessment Strategies suggest methods to assess the achievement of the PLOs. The Recommended Learning Resources list all resources that are recommended by the Ministry of Education as being linked to the IRP for that grade level and subject.

The British Columbia Ministry of Education created a framework document in 1995, 'Environmental Concepts in the Classroom: A Guide for Teachers' as part of IRPs to serve as a guideline to environmental education. The document introduces six guiding principles for integrating environmental education into the classroom setting; however, it does not discuss the benefits of integrating environment and sustainability themes, nor does it give examples of specific teaching methods or specific resources. Arai and Sprules (2001) conducted a study that assessed the status of environmental education in British Columbia public schools and found that many environmentally minded teachers feel that the framework document is inadequate. In addition, this document was not commonly used and many were not aware of its existence; 80% of teachers in Vancouver surveyed were unaware of the Ministry's document. In general, teachers rated the effectiveness of each subject's IRP differently. In addition, the number and

the depth of environmental topics covered in the curriculum varied between grade levels. The curriculum is set up in a way that splits all the grades and subjects into separate teaching compartments, making it difficult for the curriculum to be regarded as an integrated whole and interdisciplinary. In the absence of specific curriculum guidelines, most teachers teach environmental education based on values and experiences rather than knowledge. These values are based on childhood experiences, recreational pursuits, concern for health and lifestyles, and involvement in social and environmental issues. 88% percent of teachers indicate they incorporate environmental education in lessons. However, a large proportion only incorporates environmental education on a monthly or weekly basis. In summary, environmental education should be interdisciplinary, relevant and frequent, but evidence does not show this to be the case in British Columbia school.

At the municipal level, individual school boards are responsible for implementing the provincial curriculum, and each board makes budget allocation decisions and chooses and/or develops their own curriculum materials. As such, they are a key player in how and to what degree environmental education is implemented in the schools. School principals and teachers also play a key role in implementing the curriculum, which implies that the environmental education reflected in the classroom varies by school and even class to class. From the questionnaire results, it was apparent that some teachers do in fact incorporate more environmental education in their lessons than others. While some teachers reported that they never include environmental education in their lessons, others reported that they include it on a daily basis. This large discrepancy is expected to relate to differences in the grade level that teachers taught, the level of teaching experience that the teachers had, and/or the personal involvement and interest that teachers had in environmental issues and activities. The decentralized responsibility for setting and implementing curriculum, spread across the provinces/territories, school boards and even individual schools, principals and teachers, makes it more difficult for groups to achieve policy changes.

In an interview with a representative of the Vancouver School Board, the representative stated that, in his opinion, environmental education is not being well taught in the classroom, though he thought it is fairly well woven into the IRPs. Teachers identified a number of obstacles to environmental education in this province, including insufficient teacher training, scarce teaching resources, inadequate funding and lack of time. First, the amount of training the teachers received varies between their teaching experiences. From survey results, it was found that teachers with 21 to 30 years of teaching experience teach a considerable amount more environmental education than teachers with more or less experience. This finding is consistent with historical events where environmental education became a major concern for politicians, parents and educators in the early 1970's. As a result, teachers with more or less than 21 to 30 years had less teaching training on environmental education. The second obstacle is scarce teaching resources. With a lack of good resources, teachers often fall back onto textbooks that may not cover environmental issues effectively and/or do not relate to the curriculum learning outcomes. Lastly, many teachers stated that they found the amount of material and learning outcomes covered in the curriculum was too overwhelming, and they were not always able to cover all the topics. Some teachers apparently do not follow the IRP very closely at all, or feel as if they did not have the time to cover anything much in any depth.

8.2 Interviews

There were a total of seven participants for the interview, which included one sustainable coordinator each from the Vancouver School Board and the Richmond School Board, two teachers each from the Vancouver School District and Richmond School District, and the representative for the Translink's TravelSmart program. Interviews were conducted after the survey implementation was completed, between March 2012 and May 2012. Participants were asked to discuss their experience with the current environmental education program, and opinions on improving environmental education in British Columbia. Obvious sample limitations can be noted. The teachers who participated in this interview might be more concerned about environmental education. Each interview consisted of an approximately 20

minute interview with an open-ended format. The interview questions can be found in Appendix D.

In general, the participants felt environmental education is not integrated well into the curriculum, and that there is lots of room for improvement. The sustainability coordinator of the VSB stated that the environment is a board topic and that it is definitely challenging to include all the subjects of environment in the curriculum. Although currently there is no mandatory environmental course, some classes such as the science and social studies do include topics related to sustainability and the environment. The sustainability coordinator of the RSB believed the amount of environmental education incorporated in the courses certainly depends on the teachers. As indicated by the teachers, most of the environmental education incorporated into their lessons based mostly on their own initiative rather than the curriculum.

For the two teachers that were aware of the 2007 "Environmental Learning and Experience Guide" distributed by the BC Ministry of Education, they found the document only somewhat useful. They prefer to use the resources that they found from the internet and media. One teacher said, "I use my own time searching through my extensive library of environmental education resources, searching relevant news stories and scientific studies, and using social media to find local news". According to the sustainability coordinators, they felt the teachers are overwhelmed with the mandatory curriculum and do not have time to cover the materials from the environmental curriculum. On the other hand, one teacher suggests the Ministry should include more materials and improve the quality of the materials in the curriculum.

During the interview, the teachers were asked what techniques they use to help their students learn about the environment. The teachers reported lecturing in the classroom, hands-on learning outdoors, having guest speakers, going on field trip and implementing practical conservation. However, the teachers indicated there is lack of funding to support many of the activities. One teacher stated "The students learn a lot from field trips, but there is always lack of funding for transportation for field trips". Conversely, the sustainability coordinator from RSB stated "Most activities do not require funding. The teachers can utilize the resources available through the schools themselves."

Furthermore, in discussing the obstacles of incorporating environmental education in the schools, the teachers and the sustainability coordinators also have different opinions. The teachers said the major obstacles are the quality of curriculum materials, field trips and equipment, and training for teachers. On the other hand, the sustainability coordinators believed the main problem is that the teachers are overwhelmed with what they are teaching. The mandatory curriculum has too much material to be covered.

In relation to environmental education on transportation, the teachers are flexible in terms of what topics they want to cover. The resources are mainly from the media on current events. The representative from the Travel Smart program said they are developing curriculum and materials for teachers and schools interested in including TravelSmart in class discussion, projects, events and resources that will be available for download through their website. They also have Travelsmart for secondary school programs introducing students to the concept of the benefits of choosing sustainable transportation option. However, only schools and students that are interested are involved in the program.

8.3 Environmental Information Acquisition

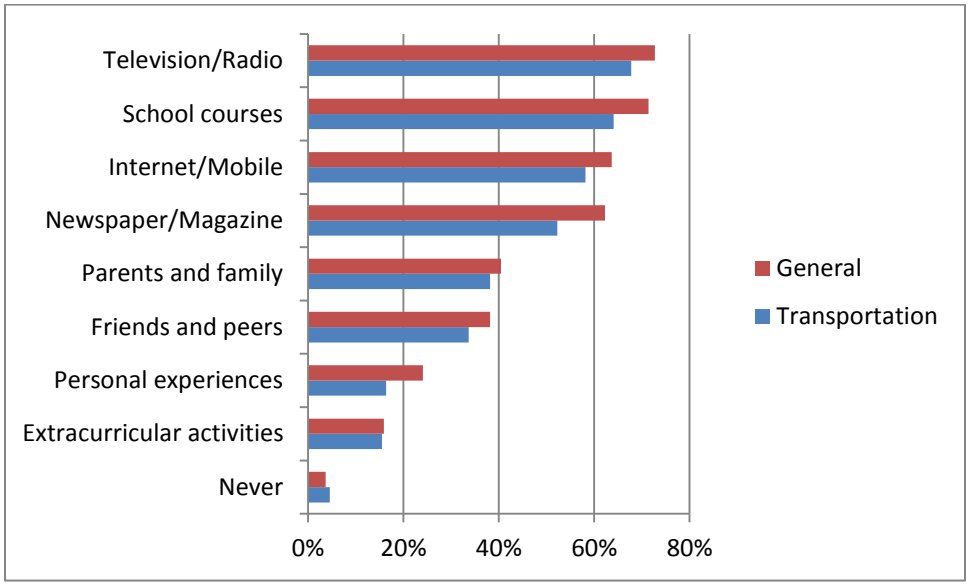
A total of 220 students completed the "Environmental Information Acquisition" section from the complete survey. Six questions were asked concerning the source and potential impact of the environmental information the students' received.

The students were asked if they have ever participated in any environment-related programs in school or in their community. 43% reported they had never participated in any environment-related programs in school or in their community. Of the students who participated in environment related programs, 75% participated in programs in school and 25% participated in programs in their community.

The students were asked to identify their information source on general and transportation related environmental issues. As shown in Figure 8.1, the students indicated that television/radio is the primary source, followed by school courses and internet/mobile.

Surprisingly, while 57% of students reported they have participated in environment related programs, only 15% stated that they receive the information from extracurricular activities.

Figure 8.1 Source of Environmental Information



The students were further asked if they want to learn more about environmental issues, 70% stated that they want to learn more about general environmental issues, and 63% want to learn more about the relations between transportation and environment. Lastly, the students were asked to what extent the environmental information they have learnt made them travel more sustainably. They stated that environmental information had a limited effect on how they travel.

8.4 Summary

The current status of environmental education in British Columbia remains in a developing phase. While there are resources available through the IRPs, the underlying problem remains in the overwhelming amount of information and also the lack of knowledge by the teachers to access this information. This said, it is recommended that the school board should look into enhancing structure around the environmental program. At this point, only teachers that are aware of such programs offered by Translink are actively incorporating them into their study plans. This said, communication of these programs should be made mandatory through information sessions. While social media plays an influential role in the student's development,

the survey indicates that environmental education will rely on the school system. With students showing a genuine interest in learning more about environmental issues, it is imperative that the school system better equip the teachers in acting as a conduit of this knowledge.

9 Discussion and Conclusions

Young people are spending more time in cars than ever before. Between 1986 and 2006, weekday travel by car for 11-15 years olds increased 83%, while the per capita increase for adults was only 11% (University of Toronto 2008). Young people who do the majority of their traveling by car while growing up may continue that behavior into adulthood and are reluctant to travel by alternative transportation modes. Reducing car use is a dominant goal of most climate change strategies and will contribute to healthier environments for young people today as well as future generations.

This research explored the relationship between environmental knowledge, attitudes and travel behavior of youth in Vancouver. It is focused on the youth because 1) they are the generation which will bear the consequences and have to find solutions to the environment problems rising today; 2) the five years at high school are the most important period for students to gain environmental knowledge; and 3) there is a good opportunity to encourage positive attitudes through formal education. The ultimate goal of this study is to influence youth to increase the use of sustainable transportation.

This final chapter is organized as follows. Section 9.1 describes the major findings of the study. Section 9.2 discusses the overall policy and research implications that are supported by the findings. Finally, section 9.3 describes the future research directions.

9.1 Major Findings

Based on the 937 student responses collected from the City of Richmond and City of Vancouver, it is found that the students lack in knowledge about the environment. On average, students answered half of the questions correctly, with only 1% of students answering more than 80% of the questions correctly. A series of ANOVA found significant differences in general knowledge and transportation-specific knowledge for the whole sample at the 5% level.

The students in general have attitudes that are protective of the environment; three-quarters of the students have positive environmental attitudes. A series of ANOVA tests found

significant differences between general environmental attitudes and transportation-specific environmental attitudes for the whole sample at the 5% level. Overall, students have more positive general attitudes than transportation-specific environmental attitudes. There is a positive correlation between general and transportation-specific attitudes, suggesting that students with positive attitudes toward general environmental issues are likely to have positive attitudes toward transportation-specific issues.

Students across five grades are compared in order to assess education's impact on environmental knowledge and attitudes. However, there were no observable increases in either general or transportation-specific knowledge or attitudes. This finding suggests that the schools' curricula do not contribute to students' environmental knowledge and attitudes.

The survey results illustrate the diversity in transportation mode used for trips to school. Students in this study made 36% of their trips to school by walking, 35% by car (12% as car driver and 23% as car passenger), 16% by public transit, 7% by school bus and 3% by bicycle. In contrast, students' ideal travel mode to school differs from their actual travel mode. More students prefer to drive and bike to school; fewer students prefer to take public transit or walk to school. 42% of students travelled to school by themselves, and the other mostly travelled with their classmates and siblings. Only 3% travelled to school with their parents. 61% of students were the sole decision makers in their commuting mode choice while the rest have their parents and guardians as decision maker. Overall, female students are more likely to be driven and fewer bike to school in comparison to male students. Male students and higher grade students have a stronger desire to drive and bike, have a higher tendency to make their own commuting decisions, and make more school trips alone.

9.1.1 Environmental Knowledge Affect Environmental Attitudes

Environmental knowledge is positively associated with pro-environmental attitudes. Students who have better knowledge of environmental issues have higher levels of pro-environmental attitudes. Both general knowledge and transportation-specific knowledge contribute to positive environmental attitudes. While general and transportation-specific attitudes are highly

correlated, the correlation between general knowledge and transportation knowledge is significant but much weaker in comparison.

Even though the structural equation models showed that students' environmental knowledge is associated positively with their environmental attitudes, only 15% of the variation in attitudes can be explained by knowledge. Environmental knowledge is an important determining factor of attitudes, but not a dominant one; many other factors also influence environmental attitudes.

9.1.2 Travel Behavior Affect Environmental Attitudes

Four structural equation models are used to assess the impact of travel behavior (Travel mode to school, travel mode from school, travel mode frequency and travel mode share) on environmental attitudes. In summary, travel behavior shows a statistically significant impact on environmental attitudes for the students whose parents made commuting decisions on their behalf. First, students who use active transportation, public transit and school buses to/from school have stronger pro-environmental attitudes than students who travel to /from school by car. Second, students who use active transportation more frequent have higher level of pro-environmental attitudes. In contrast, students who use car more frequent have lower levels of pro-environmental attitudes. Third, active transportation, public transit and school buses mode share have significant and positive impacts on environmental attitudes compared to car mode share. Lastly, general environmental attitudes and transportation-specific environmental attitudes are highly correlated. Therefore, there are similar impacts of travel behavior on both attitudes.

Despite the significant relationships between travel behaviors and environmental attitudes, the r-square values of ENVATT are less than 21%. This suggests that travel behavior, together with socioeconomic and demographic variables, can explain environmental attitudes only to a limited extent.

9.1.3 The Relationship between Environmental Knowledge, Attitudes and Travel Behavior

Three possible relationships between environmental knowledge, attitudes and travel behavior were explored. There are three major findings that emerge from the analysis. First, environmental attitude is found to be a mediating variable between environmental knowledge and travel behavior. Second, environmental knowledge is not a confounder to the effect of environmental attitudes on travel behavior. Lastly, environmental knowledge has a significant impact on the relationship between environmental attitudes and travel behavior.

9.2 Research and Policy Implications

The survey results indicate that there is a discrepancy between students' actual travel mode and ideal travel mode to school. Many students who currently walk and use public transit to school prefer to drive to school. This is probably because the majority of students are not at the age to obtain a driver license. Previous research has shown that the travel behavior intentions of young people between the ages of 11 and 18 are dominated by the desire to drive and/or own a car in the future (Turner and Pilling 1999; Storey and Brannen 2000; Derek Halden Consultancy 2003). Travel behavior usually changes at the age of 17, after the age of license acquisition, when young people move from other modes to being car drivers. This research is developed with the goal to influence young people to be less reliant on the car and more reliant on alternative modes before the age of license acquisition. Having better understanding on the relationship between environmental knowledge, attitudes and travel behavior of youth can contribute to the development and improvement of the environmental education programs in their connection to travel behavior.

Based on the review of the environmental education curriculum of British Columbia, interviews with teachers and representatives from the School Board, and students' survey results, demand for environmental education exceeds what the Ministry of Education and School Boards currently offer. The students in general have poor knowledge about the environment, but they show a genuine interest in learning more about general and transportation related environment issues. The teachers want to improve the environmental education but there is a

lack of resources available to them (ex. quality of curriculum materials, field trips and equipment, and training for teachers). Sustainability coordinators also felt environmental education is not integrated well into curriculum and the teachers are overwhelmed with what they are teaching. This suggests the current state of environmental education in British Columbia remains in a developing phase, and there is a lot of room for improvement.

There are significant correlations between environmental knowledge and attitudes, and attitudes and travel behavior. Even though environmental knowledge does not have a direct impact on travel behavior, their significant relationships suggest environmental attitude is a mediating variable between environmental knowledge and travel behavior. Therefore, continual improvement of the environmental education curriculum is recommended, but the curriculum should not be limited to knowledge-based education on transportation. Rather, it should include activities that will help induce positive environmental attitudes.

Social media and school courses are currently the major sources for environmental information for the students. Hence, educational institutes, government, environmental NGOs should continue to leverage these channels to effectively disburse information. Meanwhile, there should be a focus to improve and develop the other conduits to which students receive environmental information. For instance, while limited amount of students stated that they have received environmental information through extracurricular activities, additional resources should be allocated to extracurricular programs so more students could gain environmental knowledge through hands-on experiences.

Lastly, parents play an important role in students' knowledge, attitudes and travel behavior. Many students stated that they have received general and transportation related information through their parents. For the students whose parents made commuting decisions for them, they are more likely to be driven to school and less likely to walk to school. Parents' perceptions about the safety of a mode positively influences the choice of the corresponding mode for school trips (McMillan 2003; Rhoulac 2005). Parents claimed that the streets closest to the school are some of the most dangerous locations for children who travel to school on foot due to the high period-specific traffic volumes and erratic driving behavior of car-bound parents

(McMillan 2005). The fear of crime and threats to personal safety is yet another hindering factor; two different surveys of parents revealed that parents were more worried that children may be abducted or harmed by a stranger than that the children would sustain a physical injury (Gilbert and O'Brien 2005). Hence, it is critical to implement safe routes to school programs that enable policymakers, community leaders and schools to improve safety and encourage more students to walk and bicycle to school. In a study of commuter behavior at the University of North Carolina, Chapel Hill, Rodriguez and Joonwon (2004) found that the likelihood to travel by foot was positively associated with an increase in the percentage of sidewalks available on the shortest route to a destination. This study also found that the appeal of walking and bicycling was affected by sloping terrain. Some communities are now being built or redeveloped to include extensive trails, sidewalks, narrow streets and traffic calming in order to facilitate walking and cycling. These changes not only increase the attractiveness of active transportation, they also reduce the risk and severity of injuries by providing a safe, secure and pedestrians- cyclists- friendly environment. Through enforcement of traffic laws around schools and engineering of the street environment along the routes to schools, parents could change their perception of safety and allow their children to travel to school by active transportation.

9.3 Research Limitations and Future Research

The limitations of this study that should be addressed in future studies. First, the conclusions are drawn based on 1032 respondents from 11 schools in the City of Richmond and City of Vancouver. It is recommended to extend this study to other school districts and engage more schools in research for a more representative sample. Second, only 220 students completed the in-class survey. The data used for analysis are mainly from the four common sections of the in-class and lunch time survey. It is suggested to get more students to participate in the in-class surveys as it explore students' environmental behavior, attitudes toward travel modes, environmental information acquisition and environmental belief and values that were not covered in the lunch time survey. Third, the students' home location cannot be obtained because of parents' concern of confidentiality. With the students' home location, the impact of

road network and public transit accessibility on travel behavior can be examined. It is essential to have full disclosure with the parents on the approval issued by the UBC Behavioral Research Ethics Board which address the parents' concern.

Future research should also be expanded to investigate the influences of parents, schools, peers on youth's attitudes and behavior. Since the survey results indicated that parents are an important source of environmental information and play a significant role in students' travel decisions, it would be valuable to conduct surveys with the parents to better understand the influence that they have on their children. In addition, social networks affect the perceptions, beliefs and actions of individuals through structural relations such as direct contact, and indirect interaction through intermediaries (Knoke and Yang 2008). An individual's network of peers could be a significant motivation for his or her opinions and actions towards the environment. Therefore, future research should examine the association between the environmental attitudes and travel behavior of an individual and his/her network. In addition, students' academic performance should also be included in the analysis. More resources should be allocated to the subject/course that has significant impact on knowledge, attitudes and travel behavior. Finally, replicating this study in other areas will hopefully validate this methodology and also bring to light any differences in environmental knowledge, attitudes and travel behavior among youth from different areas.

References

Ajzen, I. (1991). "The theory of planned behavior." Organizational Behavior and Human Decision Processes 50(2): 179-211.

Anable, J., B. Lane, et al. (2006). An Evidence Base Review of Public Attitudes to Climate Change and Transport Behaviour, Department for Transport.

Arai, E. and S. Sprules (2001). The Status of Environmental Education in British Columbia Public Schools: Grade 6, 7 and 8 in the Vancouver School District as a Case Study. Vancouver, The University of British Columbia. Undergraduate.

Arbuthnot, J. (1977). "The roles of attitudinal and personality variables in the prediction of environmental behavior and knowledge." Environment and Behavior 9(2): 217-232.

Arcury, T. A. (1990). "Environmental Attitudes and Environmental Knowledge." Human Organization 49: 300-304.

Arcury, T. A., T. P. Johnson, et al. (1986). "Ecological Worldview and Environmental Knowledge: The "New Environmental Paradigm"." The Journal of Environmental Education 17(4): 35-40.

Assael, H. and G. S. Day (1968). "Attitudes and Awareness as Predictors of Market Share." Journal of Advertising Research 8(4): 3-10.

Axhausen, K. W., A. Simma, et al. (2001). "Pre-commitment and usage: seasontickets, cars and travel." European Research in Regional Science 11: 101-110.

Bamberg, S., I. Ajzen, et al. (2003). "Choice of Travel Mode in the Theory of Planned Behavior: The Roles of Past Behavior, Habit, and Reasoned Action." Basic and Applied Social Psychology 25(3): 175 - 187.

Bamberg, S. and P. Schmidt (1998). "CHANGING TRAVEL-MODE CHOICE AS RATIONAL CHOICE." Rationality and Society 10(2): 223-252.

Banister, D. and R. Hickman (2006). "How to design a more sustainable and fairer built environment: transport and communications." Intelligent Transport Systems, IEE Proceedings 153(4): 276-291.

Baron, R. M. and D. A. Kenny (1986). "The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations." Journal of Personality and Social Psychology 51(6): 1173-1182.

Ben-Akiva, M., D. McFadden, et al. (2002). "Hybrid Choice Models: Progress and Challenges." Marketing Letters 13(3): 163-175.

Bentler, P. M. (1990). "Comparative fit indexes in structural models." Psychological Bulletin 107(2): 238-246.

Blake, D. E., N. Guppy, et al. (1997). "Canadian Public Opinion and Environmental Action: Evidence from British Columbia." Canadian Journal of Political Science/Revue canadienne de science politique 30(03): 451-472.

Blum, A. (1987). "Students' Knowledge and Beliefs concerning Environmental Issues in Four Countries." The Journal of Environmental Education 18(3): 7-13.

Bradley, Waliczek, et al. (1999). "Relationship Between Environmental Knowledge and Environmental Attitude of High School Students " Journal of Environmental Education 30(3).

Bristow, A., A. Pridmore, et al. (2004). How can we reduce carbon emissions from transport? Tyndall Centre Technical Report 15. Leeds, Tyndall Centre for Climate Change Research.

Browne, M. W. and R. Cudeck (1992). "Alternative Ways of Assessing Model Fit." Sociological Methods & Research 21(2): 230-258.

Browne, M. W. and M. G. (1990). RAMONA user's guide, Ohio State University.

Carmines, E. G. and R. A. Zeller (1979). Reliability and Validity Assessment. Newbury Park, CA, Sage Publications Inc.

Chan, K. (1996). "Environmental attitudes and behaviour of secondary school students in Hong Kong." The Environmentalist 16(4): 297-306.

Choo, S. and P. Mokhtarian (2002). "The relationship of vehicle type choice to personality, lifestyle, attitudinal, and demographic variables." Davis, CA: Institute of Transportation Studies, University of California at Davis.

Choocharukul, K., H. T. Van, et al. (2008). "Psychological effects of travel behavior on preference and lifestyle in influencing vehicle type choice." Transportation Research Part A 42(1): 116-124.

City of Vancouver (2012). Greenest City 2020 Action Plan. Vancouver, BC.

Cohen, J., P. Cohen, et al. (2003). Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. Mahwah, NJ, USA, Lawrence Erlbaum Associates.

Cohen, M. J. (1984). Prejudice against nature. Freeport, ME, Cobble-smith.

Cronbach, L. J. and P. E. Meehl (1955). "Construct validity in psychological tests." Psychological Bulletin 52(4): 281-302.

Den Boon, A. K. (1980). Opvattingen over Autogrebruik en Milieuvervuiling, University of Amsterdam.

Department of the Environmental Transport and the Regions (1999). Every Little Bit Helps: Are You Doing Your Bit? United Kingdom.

Derek Halden Consultancy (2003). Children's Attitudes to Sustainable Transport. Edinburgh, Scottish Executive Social Research.

DeVellis, R. F. (2003). Scale development: Theory and application. Thousand Oaks , CA, Sage.

DeVon, H. A., M. E. Block, et al. (2007). "A Psychometric Toolbox for Testing Validity and Reliability." Journal of Nursing Scholarship 39(2): 155-164.

DiGuiseppi, C., I. Roberts, et al. (1998). "Determinants of car travel on daily journeys to school: cross sectional survey of primary school children." BMJ 316(7142): 1426-1428.

Dobson, R., F. Dunbar, et al. (1978). "Structural models for the analysis of traveler attitude-behavior relationships." Transportation 7(4): 351-363.

Dunlap, R. E. (1978). "The new environmental paradigm: a proposed instrument and preliminary results." The Journal of Environmental Education 9: 10-19.

Dunlap, R. E., K. D. Van Liere, et al. (2000). "New Trends in Measuring Environmental Attitudes: Measuring Endorsement of the New Ecological Paradigm: A Revised NEP Scale." Journal of Social Issues 56(3): 425-442.

Flamm, B. (2009). "The impacts of environmental knowledge and attitudes on vehicle ownership and use." Transportation Research Part D: Transport and Environment 14(4): 272-279.

Forward, S. E. (1998). Behavioural Factors Affecting Modal Choice: ADONIS. Sweden, Swedish National Road and Transport Research Institute.

Gagnon Thompson, S. C. and M. A. Barton (1994). "Ecocentric and anthropocentric attitudes toward the environment." Journal of Environmental Psychology 14(2): 149-157.

Gambro, J. S. and H. N. Switzky (1996). "A national survey of high school students' environmental knowledge." Journal of Environmental Education 27(3): 28.

Gärling, T. (1998). Behavioural Assumptions Overlooked in Travel-Choice Modeling. Oxford, UK, Elsevier.

Gilbert, R. and C. O'Brien (2005). Child- and youth-friendly land-use and transport planning guidelines. Toronto, Ontario, The Centre for Sustainable Transportation

Golob, T. F. (2001). "Joint models of attitudes and behavior in evaluation of the San Diego I-15 congestion pricing project." Transportation Research Part A: Policy and Practice 35(6): 495-514.

Golob, T. F. (2003). "Structural equation modeling for travel behavior research." Transportation Research Part B: Methodological 37(1): 1-25.

Golob, T. F. and D. A. Hensher (1998). "Greenhouse gas emissions and australian commuters' attitudes and behavior concerning abatement policies and personal involvement." Transportation Research Part D: Transport and Environment 3(1): 1-18.

Golob, T. F., A. D. Horowitz, et al. (1979). Attitude-Behavior Relationships in Travel Demand Modeling. London, Croom Helm.

Gopinath, A. D. (1995). Modeling Heterogeneity in Discrete Choice Processes: Application to Travel Demand. Department of Civil and Environmental Engineering, Massachusetts Institute of Technology. Ph.D.

Government of Canada (2010, June 2, 2010). "2008 Canadian Transportation Greenhouse Gas Emissions by Mode." Retrieved August 1, 2012, from http://www.climatechange.gc.ca/default.asp?lang=En&n=36BDD00A-1.

Greening, L. A., D. L. Greene, et al. (2000). "Energy efficiency and consumption — the rebound effect — a survey." Energy Policy 28(6–7): 389-401.

Hair, J. F., R. E. Anderson, et al. (1998). Multivariate Data Analysis with Readings. Englewood Cliffs, NJ, Prentice Hall.

Handy, S., X. Cao, et al. (2005). "Correlation or causality between the built environment and travel behavior? Evidence from Northern California." Transportation Research Part D: Transport and Environment 10(6): 427-444.

Hausbeck, K. W., L. W. Milbrath, et al. (1992). "Environmental Knowledge, Awareness and Concern Among 11th-Grade Students: New York State." The Journal of Environmental Education 24(1): 27-34.

He, K., H. Huo, et al. (2004). "Oil consumption and CO2 emissions in China's road transport: current status, future trends, and policy implications." Energy Policy 33(12): 1499-1507.

He, X., T. Hong, et al. (2011). "A comparative study of environmental knowledge, attitudes and behaviors among university students in China." International Research in Geographical and Environmental Education 20(2): 91-104.

Hounsham, S. (2006). Painting the Town Green: how to persuade people to be environmentally friendly – a report for everyone involved in promoting greener lifestyles to the public. London, Green-Engage.

Hu, L. t. and P. M. Bentler (1999). "Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives." Structural Equation Modeling: A Multidisciplinary Journal 6(1): 1-55.

Isenhour, C. (2010). "On conflicted Swedish consumers, the effort to stop shopping and neoliberal environmental governance." Journal of Consumer Behaviour 9(6): 454-469.

Ivy, T. G.-C., K. S. Road, et al. (1998). "A Survey of Environmental Knowledge, Attitudes and Behaviour of Students in Singapore." International Research in Geographical and Environmental Education 7(3): 181-202.

Jakobsson, C., S. Fujii, et al. (2000). "Determinants of private car users' acceptance of road pricing." Transport Policy 7(2): 153-158.

Jaus, H. H. (1982). "The effect of environmental education instruction on children's attitudes toward the environment." Science Education 66(5): 689-692.

Kaiser, F. G., S. Wölfing, et al. (1999). "ENVIRONMENTAL ATTITUDE AND ECOLOGICAL BEHAVIOUR." Journal of Environmental Psychology 19(1): 1-19.

Kallgren, C. A. and W. Wood (1986). "Access to attitude-relevant information in memory as a determinant of attitude-behavior consistency." Journal of Experimental Social Psychology 22(4): 328-338.

Kilbourne, W. E., S. C. Beckmann, et al. (2002). "The role of the dominant social paradigm in environmental attitudes: a multinational examination." Journal of Business Research 55(3): 193-204.

Kitamura, R., P. L. Mokhtarian, et al. (1997). "A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area." Transportation 24(2): 125-158.

Kitamura, R. and Y. O. Susilo (2005). "IS TRAVEL DEMAND INSATIABLE? A STUDY OF CHANGES IN STRUCTURAL RELATIONSHIPS UNDERLYING TRAVEL." Transportmetrica 1(1): 23-45.

Kline, R. B. (2010). Principles and Practice of Structural Equation Modeling. New York, Guildford.

Knoke, D. and S. Yang (2008). Social Network Analysis. Los Angeles, Sage.

Kollmuss, A. and J. Agyeman (2002). "Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior?" Environmental Education Research 8(3): 239-260.

Kopnina, H. (2011). "Kids and cars: Environmental attitudes in children." Transport Policy 18(4): 573-578.

Kuhlemeier, H., H. V. D. Bergh, et al. (1999). "Environmental knowledge, attitudes, and behavior in Dutch secondary education." Journal of Environmental Education 30(2): 4.

Lanken, B., H. Aarts, et al. (1994). "Attitude Versus General Habit: Antecedents of Travel Mode Choice1." Journal of Applied Social Psychology 24(4): 285-300.

Liere, K. D. V. and R. E. Dunlap (1980). "The Social Bases of Environmental Concern: A Review of Hypotheses, Explanations and Empirical Evidence." Public Opinion Quarterly 44(2): 181-197.

Line, T., K. Chatterjee, et al. (2010). "The travel behaviour intentions of young people in the context of climate change." Journal of Transport Geography 18(2): 238-246.

Loewenstein, G. (2001). "The Creative Destruction of Decision Research." Journal of Consumer Research 28(3): 499-505.

Lyon, P. K. (1984). "Time-dependent structural equations modeling: A methodology for analyzing the dynamic attitude – behavior relationship." Transportation Science 18(4): 395-414.

MacCallum, R. C., M. W. Browne, et al. (1996). "Power analysis and determination of sample size for covariance structure modeling." Psychological Methods 1(2): 130-149.

Makki, M. H., F. Abd-El-Khalick, et al. (2003). "Lebanese Secondary School Students' Environmental Knowledge and Attitudes." Environmental Education Research 9(1): 21-33.

Maloney, M. P. and M. P. Ward (1973). "Ecology: Let's hear from the people: An objective scale for the measurement of ecological attitudes and knowledge." American Psychologist 28(7): 583-586.

Mangas, V. J., P. Martinez, et al. (1997). "Analysis of Environmental Concepts and Attitudes Among Biology Degree Students." The Journal of Environmental Education 29(1): 28-33.

McFadden, D. (2000). Disaggregate Behavioral Travel Demand's RUM Side: A 30-Year Retrospective. International Association of Travel Behavior Research (IATBR) Conference. Gold Coast, Queensland, Australia.

McMillan, T. E. (2003). Walking and urban form: modeling and testing parental decisions about children's travel. Irvine, University of California. PhD.

McMillan, T. E. (2005). "Urban Form and a Child's Trip to School: The Current Literature and a Framework for Future Research." Journal of Planning Literature 19(4): 440-456.

Meinhold, J. L. and A. J. Malkus (2005). "Adolescent Environmental Behaviors." Environment and Behavior 37(4): 511-532.

Morikawa, T. and K. Sasaki (1998). Discrete choice models with latent variables using subjective data. Travel Behaviour Research: Updating the State of Pla. Pergamon, Oxford: 435-455.

Muller, D., C. M. Judd, et al. (2005). "When moderation is mediated and mediation is moderated." Journal of Personality and Social Psychology 89(6): 852-863.

Munro, B. H. (2005). Statistical Methods for Health Care Research. Philadelphia, PA., Lippincott Williams and Wilkins.

Munson, B. H. (1994). "Ecological Misconceptions." The Journal of Environmental Education 25(4): 30-34.

Muthen, L. and B. Muthen (2007). Mplus Statistical Analysis with Latent Variables User's Guide.

Negev, M., G. Sagy, et al. (2008). "Evaluating the Environmental Literacy of Israeli Elementary and High School Students." Journal of Environmental Education 39(2): 3-20.

Nilsson, M. and R. Küller (2000). "Travel behaviour and environmental concern." Transportation Research Part D: Transport and Environment 5(3): 211-234.

Nunnally, J. C. and I. H. Bernstein (1994). Psychometric theory. New York, McGraw-Hill.

Ory, D. T. and P. L. Mokhtarian (2009). "Modeling the structural relationships among short-distance travel amounts, perceptions, affections, and desires." Transportation Research Part A: Policy and Practice 43(1): 26-43.

Outwater, M., S. Castleberry, et al. (2003). "Attitudinal Market Segmentation Approach to Mode Choice and Ridership Forecasting: Structural Equation Modeling." Transportation Research Record: Journal of the Transportation Research Board 1854(-1): 32-42.

Pearl, J. (1998). Why there is no statistical test for confounding, why many think there is, and why they are almost right. Los Angeles, Department of Computer Science, University of California.

Pendyala, R. M. (1998). Causal Analysis in Travel Behaviour Research: A Cautionary Note. Pergamon, Oxford, Elsevier.

Ramsey, C. E. and R. E. Rickson (1976). "Environmental Knowledge and Attitudes." The Journal of Environmental Education 8(1): 10-18.

Reibstein, D. J., C. H. Lovelock, et al. (1980). "The Direction of Causality between Perceptions, Affect, and Behavior: An Application to Travel Behavior." Journal of Consumer Research 6(4): 370-376.

Rhoulac, T. (2005). "Bus or Car?: The Classic Choice in School Transportation." Transportation Research Record: Journal of the Transportation Research Board 1922(-1): 98-104.

Rodríguez, D. A. and J. Joo (2004). "The relationship between non-motorized mode choice and the local physical environment." Transportation Research Part D: Transport and Environment 9(2): 151-173.

Shanahan, J. (1993). Television and the Cultivation of Environmental Concern. Leicester, Leicester University Press.

Singleton, R. A. and B. C. Straits (1999). Approaches to Social Research. New York and Oxford, Oxford University Press.

Stapp, W. (1978). "An instructional model for environmental education." Prospects: Quarterly Review of Education 8(4): 495-507.

Statistics Canada (2010, May 13, 2010). "Greenhouse Gas Emissions from Private Vehicles in Canada, 1990 to 2007." Retrieved August 1, 2012, from http://www.statcan.gc.ca/pub/16-001-m/2010012/part-partie1-eng.htm.

Steiger, J. H. (1989). A supplementary module for SYSTAT and SYGRAPH, Evanston IL: SYSTAT.

Steiger, J. H. and J. C. Lind (1980). Statistically based tests for the number of common factors. Annual Meeting of the Psychometric Society. Iowa City, IA.

Stern, P. C. and S. Oskamp (1987). Managing scarce environmental resources. New York, Wiley.

Storey, P. and J. Brannen (2000). Young People and Transport in Rural Areas. Leicester, National Youth Agency.

Tardiff, T. J. (1977). "Causal inferences involving transportation attitudes and behavior." Transportation Research 11(6): 397-404.

The United Nations Conference on Environment and Development (1993). The Earth Summit the United Nations Conference on Environment and Development 1992. Rio de Janeiro, Graham & Trotman, London.

Tikka, P. M., M. T. Kuitunen, et al. (2000). "Effects of Educational Background on Students' Attitudes, Activity Levels, and Knowledge Concerning the Environment." The Journal of Environmental Education 31(3): 12-19.

Tilbury, D. (1994). "The critical learning years for environmental education." Environmental Education at the Early Childhood Level. Washington, DC: North American Association for Environmental Education: 11-13.

Tischer, M. L. and R. V. Phillips (1979). "The relationship between transportation perceptions and behavior over time." Transportation 8(1): 21-36.

Trochim, W. M. K. (2001). The Research Methods Knowledge Base. Cincinnati , OH, Atomic Dog Publishing.

Trochim, W. M. K. (2005). Research Methods: The Concise Knowledge Base. Cincinati, Atomic Dog Publishing.

Turner, J. and A. Pilling (1999). Integrating young people into integrated transport: a community-based approach to increase travel awareness. Young People and Transport Conference.

University of Toronto (2008). 2006 Transportation Tomorrow Survey. Toronto, Data Management Group.

Walton, D., J. A. Thomas, et al. (2004). "Commuters' concern for the environment and knowledge of the effects of vehicle emissions." Transportation Research Part D: Transport and Environment 9(4): 335-340.

Waltz, C. F., O. L. Strickland, et al. (2005). Measurement in Nursing and Health Research. New York, Springer Publishing Co.

Weigel, R. H. and L. S. Newman (1976). "Increasing attitude-behavior correspondence by broadening the scope of the behavioral measure." Journal of Personality and Social Psychology 33(6): 793-802.

Wilson, R. (1994). Environmental Education at the Early Childhood Level. Washington, DC, North American Association for Environmental Eduaiton.

Worsley, A. and G. Skrzypiec (1998). "Environmental attitudes of senior secondary school students in South Australia." Global Environmental Change 8(3): 209-225.

Appendices

Appendix A: Application Package to School Board

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Assent Form

Environmental Attitude and Travel Behavior Study of Youth

Principal Investigator: Dr. Jinhua Zhao
Assistant Professor
Department of Civil Engineering, UBC

Co-Investigator: Cindy Tse
Master of Applied Science Student
Department of Civil Engineering, UBC

Kevin Millsip
Coordinator for Sustainability
Vancouver School Board

Dear Student,

We are conducting a research study entitled "Environmental Attitude and Travel Behavior Study of Youth". This research aims to examine the students' environmental attitude and its correlation with travel behavior. This survey is carried out by University of British Columbia (UBC) in collaboration with Vancouver School Board.

I am inviting you to complete a questionnaire that will take about 20 to 30 minutes. Your parents or legal guardians have already given permission for you to participate in this study, but you do not have to participate if you choose. You may quit this study at any time. Your participation in this study will not affect your grades in any way. There are no known risks involved in this study. All information collected in the survey will be strictly confidential. No one at the high school will have access to any of the data collected. The data records will be stored in the principal investigator and co-investigator's computers with password protection. Hard copies will be locked in the office of the Principal Investigator at the Department of Civil Engineering at UBC. The data will be used for academic research only.

Should you have any questions about the study, please contact the research team or your homeroom teacher. If you like to learn more about your rights as a research participant, please contact UBC Behavioral Research Ethics Board at 604.822-8598, toll free at 1-877-822-8598, or e-mail to RSIL@ors.ubc.ca.

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Please give your permission by signing the enclosed assent form and returning it to your homeroom teacher. Please keep this letter for your own records.

Sincerely,

Jinhua Zhao

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Agree to Participate

I agree to participate in the study entitled **"**Environmental Attitude and Travel Behavior Study of Youth**"** and I have received a copy of this form.

Student's Name (please print)

Student's Signature Date

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA

Consent Form

Environmental Attitude and Travel Behavior Study of Youth

Principal Investigator: Dr. Jinhua Zhao
Assistant Professor
Department of Civil Engineering, UBC

Co-Investigator: Cindy Tse
Master of Applied Science Student
Department of Civil Engineering, UBC

Kevin Millsip
Coordinator for Sustainability
Vancouver School Board

Dear Parents or Guardians,

We are conducting a research study entitled "Environmental Attitude and Travel Behavior Study of Youth". This research aims to examine the environmental knowledge, attitudes and travel behavior of youth in Vancouver public schools. The findings should be of particular interest to educational institutes, government, environmental groups and social organizations to improve the environmental education, with the goal to encourage students' toward more sustainable travel. This survey is carried out by the University of British Columbia (UBC) in collaboration with Vancouver School Board.

Participants in the study will be asked to complete a survey. The total time to participate in the study will be approximately 20 to 30 minutes. Participants will be asked to provide their household information (such as income, car vehicle ownership, dwelling type, etc.) in the last section of the survey. Participants can skip any questions that they do not want to answer.

All information collected in the survey will be strictly confidential. No one at the high school will have access to any of the data collected. The data records will be stored in the principal investigator and co-investigator's computers with password protection. Hard copies will be locked in the office of the Principal Investigator at the Department of Civil Engineering at UBC. The data will be used for academic research only.

Participation in the study is entirely voluntary and there will be no penalty for not participating. All students for whom we have parent consent will be asked if they wish to participate and only those who agree will complete the forms. Moreover, participants will be free to stop their participation in the study at any time.

Should you have any questions about the study, please contact the research team. If you like to learn more about your youngster's rights as a research participant, please contact UBC Behavioral Research Ethics Board at 604.822-8598, toll free at 1-877-822-8598, or e-mail to RSIL@ors.ubc.ca.

Please give your permission by signing the enclosed consent form and having your youngster return it to his or her homeroom teacher. Please keep this letter for your own records.

Sincerely,

Jinhua Zhao

PhD. Assistant Professor
Department of Civil Engineering / School of Community and Regional Planning
University of British Columbia

Consent to Participate

I have read the attached informed consent letter and agree to have my youngster participate in the study entitled **"**Environmental Attitude and Travel Behavior Study of Youth**."**

I consent / I do not consent (please circle one) to my youngster's participation in this study.

Student's Name

Parent's or Guardian's Name (please print)

Parent's or Guardian's Signature Date

1. Introduction

Environmental Attitude and Travel Behavior of Youth

Thank you very much for participating in this survey.
This research aims to examine students' environmental attitude and its correlation with travel behavior. This survey is carried out by the University of British Columbia.

This survey includes 8 sections:

1. Environmental Attitudes and Behavior
2. Environmental Assessment and Knowledge
3. Travel to School
4. Attitudes toward Travel Modes
5. Perceptions of Cycling
6. Environmental Information Acquisition
7. Personal and Household Information
8. Environmental Belief and Values

It takes about 30 minutes to complete the questionnaire. All information provided will be kept strictly confidential. The data will be used for academic research only. If you have any questions about the survey, please feel free to contact the research team.

Principal Investigator:
Dr. Jinhua Zhao
Assistant Professor
Department of Civil Engineering, UBC

Co-Investigators:
Cindy Tse
Master of Applied Science Student
Department of Civil Engineering, UBC

Kevin Millsip
Coordinator for Sustainability
Vancouver School Board

2. Environmental Attitudes and Behavior

1. Have you ever changed your travel behavior because of the concern of the environment?

◯ Yes ◯ No

2. Have you ever encouraged other people to change his/her travel behavior because of the concern of the environment?

◯ Yes ◯ No

3. Listed below are statements on environmental attitudes. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, NEUTRAL, MILDLY DISAGREE or STRONGLY DISAGREE.

	Strongly Agree	Mildly Agree	Neutral	Mildly Disagree	Strongly Disagree
Being environmentally responsible is important to me	◯	◯	◯	◯	◯
For the sake of the environment, car users should pay higher taxes	◯	◯	◯	◯	◯
The government shouldn't force people to change in order to protect the environment	◯	◯	◯	◯	◯
We should not have to bring inconvenience to our daily lives in order to protect the environment	◯	◯	◯	◯	◯
The government should raise the price of gasoline to reduce congestion and air pollution	◯	◯	◯	◯	◯
It is important to build more roads to reduce congestion even if it will increase pollution	◯	◯	◯	◯	◯
We should reduce car usage to reduce pollution	◯	◯	◯	◯	◯
I do not need to protect the environment if people around me do not pay attention to the environment	◯	◯	◯	◯	◯
The government should encourage the use of cars in the city to stimulate economic growth through increase in consumption	◯	◯	◯	◯	◯
In order to protect the environment, I would cycle and walk more, because these mode do not pollute	◯	◯	◯	◯	◯
In the current state of Canada, economic development is more important than the protection of the environment	◯	◯	◯	◯	◯
The Government should provide incentives to people who travel by electric vehicles, public transport, bicycle or on foot	◯	◯	◯	◯	◯
Purchase and use of private cars is freedom of choice, I will buy and use even if it will damage the environment	◯	◯	◯	◯	◯
The government should take more lead in protecting the environment, even if people don't like it	◯	◯	◯	◯	◯
The government should legislate on categorizing wastes into recyclable categories	◯	◯	◯	◯	◯

4. Below is a list of daily life activities. Which of the following activities did you perform in the past year?

	Always	Sometimes	Rarely	Never
Sort batteries or electronic products into specified recycling bins	◯	◯	◯	◯
Purchase and use of energy-saving light bulbs	◯	◯	◯	◯
Shut down water taps after use	◯	◯	◯	◯
To protect the environment, refuse to use disposable tableware when eating out	◯	◯	◯	◯
Sort household wastes into recyclable and non-recyclable categories	◯	◯	◯	◯
Take initiative to pick up and deposit waste found in a public area into recycling bins and garbage cans	◯	◯	◯	◯
Bring reusable shopping bags when shopping at supermarket or mall	◯	◯	◯	◯

5. Did you perform the following in the past year?

	Always	Sometimes	Rarely	Never
Discuss with friends about problems related to the environment	◯	◯	◯	◯
Dissuade and stop other people from littering in the public	◯	◯	◯	◯
Make recommendations to school or relevant government departments to solve environmental problems	◯	◯	◯	◯
Encourage others to participate in environmental protection activities	◯	◯	◯	◯
Participate in activities of environmental organizations or give donations	◯	◯	◯	◯
Participate in community service related to the environment	◯	◯	◯	◯

3. Environmental Assessment and Knowledge

1. How serious are the environmental problems in Vancouver?

◯ Very Serious ◯ Serious ◯ Not Serious ◯ No Problem

2. How serious is the pollution caused by traffic in Vancouver?

◯ Very Serious ◯ Serious ◯ Not Serious ◯ No Problem

3. Which of the following transportation method create the least pollution?

◯ Bus ◯ Train ◯ Cycling ◯ Car

4. Clothes Washing powder causes water pollution mainly because it contains:

◯ Chlorine ◯ Nitrogen ◯ Phosphorus ◯ Potassium

5. The carbon of "carbon emissions" refers to:

◯ Carbon monoxide ◯ Carbon dioxide ◯ Coal ◯ Carbohydrate

6. What percentage of the world total CO2 emission does transport sector account for?

◯ 2% ◯ 25% ◯ 50% ◯ 90%

7. Which of the following statement about ecological footprint is not correct?

◯ The ecological footprint is a measure of human demand on the Earth's ecosystems.

◯ It represents the amount of biologically productive land and sea area needed to regenerate the resources a human population consumes and to absorb and render harmless the corresponding waste.

◯ Although present human life style continues to increase the ecology footprint, the total is still within Earth's bearing capacity

◯ Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle.

8. "Biodiversity"means:

- ◯ Each living thing has many characteristics
- ◯ Each kind of living thing has many varieties
- ◯ Organic food has many varieties
- ◯ Diversity of Biological species, ecosystem and gene multiplicity

9. Which of the following statements about greenhouse effect is incorrect?

- ◯ The greenhouse effect is caused by greenhouse gases selective absorption of radiation which results in rise of surface temperature
- ◯ The main greenhouse gas is carbon dioxide
- ◯ Increased concentration of carbon dioxide in recent decades is a natural occurring process, not as a result of human activity.
- ◯ Current atmospheric CO2 concentration is increasing rapidly, while the increase of greenhouse gases cause global warming

10. Which of the following type of fuel produce the most carbon dioxide emissions?

- ◯ Compressed Natural Gas
- ◯ Ethanol
- ◯ Petroleum-based fossil-fuels
- ◯ Bio-diesel

11. Which of the following waste materials can not be recycled?

- ◯ Waste paper, waste plastic
- ◯ Expired drugs
- ◯ Glass, metal
- ◯ Fabric

12. Which of the following strategy does not reduce CO2 emission in urban transport?

- ◯ Use alternative fuel vehicle
- ◯ Limit car ownership and usage
- ◯ Improve fuel economy
- ◯ Reduce public transportation services

13. "Organic food " means:

- ◯ Food with no environmental impact
- ◯ Food produced without using synthetic pesticides, hormones, food additives and other production
- ◯ Uncontaminated food
- ◯ Food produced using genetic modification

14. Which country is the world's largest oil consumer?

- ◯ United States
- ◯ China
- ◯ Japan
- ◯ Canada

15. Which of the following transport sector has the highest energy consumption in Canada?

◯ Railways ◯ Highways ◯ Waterways ◯ Aviation

16. What percentage of British Columbia's greenhouse gas emissions come from Metro Vancouver cars?

◯ 50% ◯ 35% ◯ 25% ◯ 10%

4. Travel to School

1. What is the distance between your home and school? (kilometers)

◯ less than 0.25km ◯ 0.25-0.5km ◯ 0.5-1km ◯ 1-2km ◯ 2-5km ◯ more than 5km

2. What was your one-way commuting time to school yesterday (in minutes)?

3. What would be your ideal one-way commuting time to school? (minutes)

◯ 5 ◯ 10 ◯ 15 ◯ 20 ◯ 30 ◯ 40 ◯ 60

4. Do you travel to school with a companion?

◯ By myself ◯ With classmates ◯ With my parents/guardians ◯ With my siblings ◯ Other

5. What was the primary travel mode for your morning commute to school yesterday?

◯ Car Driver ◯ School Bus ◯ Bike
◯ Car Passenger ◯ Taxi ◯ Other
◯ Public Transit ◯ Walk

6. What did you do after you leave school yesterday?

◯ Go Home ◯ Shopping
◯ Personal Business (e.g., bank, dentist) ◯ Work
◯ Recreational/Social (e.g., movie, sport) ◯ Other
◯ Dining/Restaurant

7. Which was your main mode of transport after you leave school yesterday?

◯ Car Driver ◯ School Bus ◯ Bike
◯ Car Passenger ◯ Taxi ◯ Other
◯ Public Transit ◯ Walk

8. What was the commuting time to your after school activity yesterday (in minutes)?

9. How often on average do you use each of the following travel modes?

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	once a fortnight	once a month	less often	never
Walk	◯	◯	◯	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯	◯	◯	◯
Public Transit Buses	◯	◯	◯	◯	◯	◯	◯	◯
School Buses	◯	◯	◯	◯	◯	◯	◯	◯
Sky Train / Commuter Rail	◯	◯	◯	◯	◯	◯	◯	◯
Taxi	◯	◯	◯	◯	◯	◯	◯	◯
Car Driver	◯	◯	◯	◯	◯	◯	◯	◯
Car Passenger	◯	◯	◯	◯	◯	◯	◯	◯

10. Who decide how you travel to school (i.e. which travel mode to use)?

◯ Myself ◯ Parents / Guardian

11. What are the factors that influence your current travel mode choice to school?

☐ Cost ☐ Convenient ☐ Road Safety

☐ Reliable ☐ Environmental ☐ Personal Safety

☐ Comfortable ☐ Health ☐ Social

12. How would you rate the safety level of your daily commute to school?

◯ Very Safe ◯ Safe ◯ Unsafe ◯ Very unsafe

13. If you were free to choose any mode of transport to and from school, what is the ideal mode you would choose?

◯ Walk ◯ Car Driver ◯ Bike

◯ Public Transit ◯ Car Passenger ◯ Other

◯ School Bus ◯ Taxi

5. Attitudes towards Transportation

1. Listed below are statements on different travel modes. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, NEUTRAL, MILDLY DISAGREE or STRONGLY DISAGREE.

	Strongly Agree	Mildly Agree	Neutral	Mildly Disagree	Strongly Disagree
To own a car ownership gives me higher social status.	◯	◯	◯	◯	◯
There is no relationship between owning a car and vanity.	◯	◯	◯	◯	◯
Riding a private car satisfies my self-esteem to a certain extent.	◯	◯	◯	◯	◯
Owning a car gives me a sense of achievement.	◯	◯	◯	◯	◯
Car is simply a transportation tool; to own one or not has nothing to do with one's pride.	◯	◯	◯	◯	◯
I feel proud to own a car.	◯	◯	◯	◯	◯
My lifestyle is dependent on car.	◯	◯	◯	◯	◯
My life would be very difficult if I cannot travel by car.	◯	◯	◯	◯	◯
Car is only one of the many transportation methods I use. I don't feel my lifestyle is dependent on car.	◯	◯	◯	◯	◯
I don't have time to think about how I travel, I just get in my car and go.	◯	◯	◯	◯	◯
I decide whether to drive, use transit or walking and cycling according to the specific circumstances when I travel.	◯	◯	◯	◯	◯
Because of my lifestyle and geographic location, I have no choice but to drive.	◯	◯	◯	◯	◯
Learning to drive and having your own car is an identity of an adult status.	◯	◯	◯	◯	◯
To be able to drive says nothing about becoming grown-up.	◯	◯	◯	◯	◯
Driving removes the dependency on others to get around. It indicates my independence and maturity.	◯	◯	◯	◯	◯
Using public transit is a decent way of traveling.	◯	◯	◯	◯	◯
People use public transit because they cannot afford a car.	◯	◯	◯	◯	◯
Using public transit will negatively affect my personal image.	◯	◯	◯	◯	◯

2. When you grow up and can afford a car by yourself, will you buy it?

◯ For Sure ◯ Maybe ◯ No

3. How would you like to travel to work when you grow up?

◯ Walk ◯ Bus ◯ Car

◯ Bike ◯ SkyTrain ◯ Other

6. Perceptions of Cycling

1. Do you own a bicycle?

◯ Yes ◯ No

2. How many bicycles does your household own?

◯ 0 ◯ 1 ◯ 2 ◯ 3 or more

3. For what purpose(s) do you ride your bike?

◯ Utility (i.e. using bike as a travel means to get to your destination) ◯ Recreational (i.e. cycling itself as fun or exercise) ◯ Both ◯ Neither

4. Please indicate the term(s) associated with cycling. (You can pick multiple answers)

☐ Fun ☐ Fast ☐ Safe

☐ Boring ☐ Slow ☐ Dangerous

☐ Clean and Green ☐ Cool ☐ Reliable

☐ Polluting and Dirty ☐ Trendy ☐ Tiring

Anything else? (please specify)

5. Listed below are statements on cycling. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, NEUTRAL, MILDLY DISAGREE or STRONGLY DISAGREE.

	Strongly Agree	Mildly Agree	Neutral	Mildly Disagree	Strongly Disagree
Cycling is a sustainable way of travel.	◯	◯	◯	◯	◯
We should cycle more because it is environment-friendly.	◯	◯	◯	◯	◯
Cycling or not cannot reflect a person's environmental attitude.	◯	◯	◯	◯	◯
Teenagers should form the habit of cycling to school because it is good for the environment.	◯	◯	◯	◯	◯
I enjoy cycling because it makes me fitter.	◯	◯	◯	◯	◯
Teenagers who cycle to school will be fitter and healthier than those who travel by car.	◯	◯	◯	◯	◯
It is not safe for teenagers to cycle because of the risk of being involved in a road accident.	◯	◯	◯	◯	◯
It is not safe for teenagers to cycle because of the risk of "Stranger Danger".	◯	◯	◯	◯	◯
Cycling is an enjoyable family activity.	◯	◯	◯	◯	◯
I love to cycle because I can get to places on my own.	◯	◯	◯	◯	◯
Cycling is an efficient way of getting around.	◯	◯	◯	◯	◯
People should cycle instead of travel by car to help reduce congestion on the roads.	◯	◯	◯	◯	◯
Cycling is a fun activity for kids but not for grown-ups.	◯	◯	◯	◯	◯

7. Environmental Information

1. Have you ever participated in any environment-related programs in school or your community?

◯ Yes, in school ◯ Yes, in my community ◯ No

2. Where do you get information on environmental issues? (You can pick multiple answers)

☐ Television/Radio ☐ School courses ☐ Friends and peers

☐ Newspaper/Magazine ☐ Extracurricular activities ☐ Personal experiences

☐ Internet/Mobile ☐ Parents and family ☐ Never

Other (please specify)

3. Where do you learn the relations between transportation and environment? (You can pick multiple answers)

☐ Television/Radio ☐ School courses ☐ Friends and peers

☐ Newspaper/Magazine ☐ Extracurricular activities ☐ Personal experiences

☐ Internet/Mobile ☐ Parents and family ☐ Never

Other (please specify)

4. Do you want to learn more about environmental issues?

◯ Yes ◯ No

5. Do you want to learn more about the relations between transportation and environment?

◯ Yes ◯ No

6. To what extent will the environmental information you've learned make you travel more sustainably?

◯ Greatly ◯ A little bit ◯ Not at all

8. Personal and Household Information

1. Your gender

◯ Male ◯ Female

2. Your grade

◯ 8 ◯ 9 ◯ 10 ◯ 11 ◯ 12

3. What is your name?

4. What is your home postal code?

5. How many cars does your household own?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3 or more

6. Do you have your own car?

- ◯ Yes
- ◯ No

7. What is your household annual income before taxes?

- ◯ Less than $25,000
- ◯ $25,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $149,999
- ◯ $150,000 and over

8. Number of household members

9. Number of children in your household (18 years or younger)

10. Number of household members with driver licenses

11. Do you have a driver license?

- ◯ Yes
- ◯ No

12. What is your home dwelling type?

- ◯ House
- ◯ Duplex
- ◯ Townhouse
- ◯ Low Rises
- ◯ High Rises

Other (please specify)

13. Does your family own or rent your home?

- ◯ Own
- ◯ Rent
- ◯ Other

14. How long have you been living in your current home?

- ◯ less than 3 months
- ◯ 3 months to 1 year
- ◯ 1 year to 3 years
- ◯ 3 years to 5 years
- ◯ more than 5 years

15. What is your e-mail address?

9. Environmental Belief and Values

1. Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, UNSURE, MILDLY DISAGREE or STRONGLY DISAGREE.

	Strongly agree	Mildly agree	Neutral	Mildly disagree	Strongly disagree	Don't understand the question
We are approaching the population limit that earth can support	◯	◯	◯	◯	◯	◯
Humans have the right to modify the natural environment to suit their needs	◯	◯	◯	◯	◯	◯
When human interfere with nature it often produces disastrous consequences	◯	◯	◯	◯	◯	◯
Human ingenuity will insure that we do NOT make the earth unlivable	◯	◯	◯	◯	◯	◯
Humans are severely abusing the environment	◯	◯	◯	◯	◯	◯
The earth has plenty of natural resources if we learn how to develop them	◯	◯	◯	◯	◯	◯
Plants and animals have as much right as humans to exist	◯	◯	◯	◯	◯	◯
The balance of nature is strong enough to cope with the impacts of modern industrial nations	◯	◯	◯	◯	◯	◯
Despite our special abilities, humans are still subject to the laws of nature	◯	◯	◯	◯	◯	◯
The so-called "ecological crisis" facing mankind has been greatly exaggerated	◯	◯	◯	◯	◯	◯
The earth is like a spaceship with very limited room and resources	◯	◯	◯	◯	◯	◯
Humans were meant to rule over the rest of nature	◯	◯	◯	◯	◯	◯
The balance of nature is very delicate and easily upset	◯	◯	◯	◯	◯	◯
Humans will eventually learn enough about how nature works to be able to control it	◯	◯	◯	◯	◯	◯
If things continue on their present course, we will soon experience a major ecological catastrophe	◯	◯	◯	◯	◯	◯

APPLICATION FOR PERMISSION TO CONDUCT RESEARCH STUDIES
IN SCHOOL DISTRICT NO. 38 (RICHMOND)
7811 Granville Avenue, Richmond, B.C. V6Y 3E3

Applicant: Cindy Tse
Present Position: Master of Applied Science student at University of British Columbia
Address: 2002-6250 Applied Science Lane, Vancouver, B.C. Canada V6T 1Z4

Title of Study: Environmental Attitude and Travel Behavior of High School Students

Statement of Problem:

The frequent use of private vehicle in urban areas has a significant impact on the environment as well as on human health. Although technical improvements such as catalytic converters and fuel efficient engines have decrease the pollution per vehicle, environmental activists argue that this alone is not a sufficient solution to the problem of continuously increasing production and overconsumption of cars. Since environmental attitudes have significant impacts on vehicle ownership and use, therefore understanding environmental attitudes and travel behavior is of increasing interest to transportation planners and policy makers.

This study will focus on the high school students between the ages of 12 to 15 as their travel behavior intentions are dominated by the desire to drive and/or own a car in the future but are not legally able to carry out this behavior yet. This study explores the links between environmental value, environmental attitude, environmental behavior, environmental assessment, environmental knowledge, travel behavior, attitudes toward different transport modes and environmental information among youths. The findings should be of particular interest to educational institutes, government, environmental groups and social organization to improve the environmental education, with the goal to influence the students' toward more sustainable travel.

Significance of Study: (i.e. How might this study contribute to the improvement of education in the Richmond School District?)

Children are recognized as an important group for the development of a sustainable environment. Studying young people's attitudes to transport and the environment is particularly important as they are the ones who will be affected by and will have to provide solutions to the environment problems arising from our current actions. Attitudes towards the environment begin to develop in childhood, it may be imperative to focus on children and young people in order to address transportation issues in the future. With the increasing trend in transporting children to various activities by car, their attitude towards the environment and car usage may otherwise become detrimental to their future environment. According to a Scottish research report, "An investigation into how children and young people view sustainability in relation to their personal transportation", delivering an understanding of sustainable transport through education is one of the most important factors in achieving change in travel behavior. Therefore, there is a need to understand the relationship between attitude, behavior and knowledge toward transportation and the environment for the development of environmental education curriculums. In particular, an emphasis should be placed to educate the students before they develop a reliance on the car after the age of license acquisition.

Number of subjects desired who are: **Students: entire grade 8 to gr 10**

Students to be selected from Grade(s): 8 to 10
How much time is required from each subject?: Students: **20-30 mins**
Will students be tested?: Individually | Small Groups | **Entire Class**
Will Applicant actually conduct study? **Yes** | No
(If no, please give the name and qualifications of person(s) who will conduct the study):

Duration of Study:	Commencement Date:	Completion Date:
One day	April, 2011	November, 2011

Date of submission of the Final Report and and one page Summary Report to the Richmond School Board: January 2012

Checklist for Application Package:

- Attach one page "Invitation to Participate in Research Study" (see template attached to this application).
- Attach outline of research methodology (i.e. design, selection of subjects, experimental treatments, etc.).
- Attach copies of all tests or questionnaires which will be given to the subjects.
- Attach the letter or certificate of approval from appropriate committees at your university or institution, including Ethics Review approval.

FOR OFFICE USE ONLY:

Application package received:

Reviewed by The Research Study Review Committee:

- Granted
- Denied

Letter to Applicant sent:

Invitation to Participate in Research Study sent to School Principal:

Revised October 2010

THE UNIVERSITY OF BRITISH COLUMBIA

Dr. Jinhua Zhao
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Research Application to the Vancouver School Board

Environmental Attitudes and Travel Behavior of Youth

Aug 18, 2011

Researcher Names:
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Study Completion Date:
December 31, 2011

Study Title:
Environmental Attitudes and Travel Behavior of Youth

Target Study Group:
High School Students in Vancouver

Dr. Jinhua Zhao
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Abstract

Children and young people are recognized as an important group for the development of a sustainable environment. Studying young people's knowledge and attitudes towards the environment is particularly important as they are the ones who will be affected by and will have to ultimately provide solutions to the environmental problems arising from our current actions. Attitudes towards the environment begin to develop in childhood, it may be imperative to focus on children and young people in order to address transportation issues in the future. This study explores the environmental knowledge, attitudes and travel behavior of youth. The findings should be of particular interest to educational institutes, government, environmental groups and social organization to improve the environmental education, with the goal to influence the students' toward more sustainable travel modes.

Research Objectives

1) To benchmark the environmental knowledge and attitude among youth (high school students)
2) To quantify to what extent these knowledge and attitudes are materialized into students' daily travel behavior
3) To identify contributing factors: formal education, public media, parents' influence, peers' interaction, etc
4) To compare youth across countries: Canada, US, China and UK.

Ideal Sample Frame and Size

1) One randomly selected class for each of the five grades in each of the 18 Secondary schools in the VSB. Once a class is chosen, all students in the class will be invited to participate in the survey
2) Total sample size target: 25 students/class * 1 class/grade * 5 grades/school *18 schools = 2,700 students

Implementation instruments (all are available and can be chosen according to each school's need)

1) *Paper based questionnaire*
   UBC can prepare the questionnaires and deliver it to the schools. We and/or the partner teachers can give a brief introduction of the project to the students, and students in the chosen class will have a dedicated 30 minutes to complete the questionnaire at school.
2) *Online based questionnaire*

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UBC has prepared an online questionnaire and we can give the URL to all the schools and classes. Students can go online and complete the questionnaire at any convenient time. A test link is here: https://www.surveymonkey.com/s/vsbtest

3) *Online based with email solicitation*
If schools have the email list of students, we can send students a cover letter in the email, explaining the project and inviting them to participate in the online survey.

Questionnaire design

This is a comprehensive 14 pages questionnaire, covering environmental value, knowledge, attitude and behavior. It consists of 10 categories of information: environmental value, environmental attitudes, environmental behavior, environmental assessment, environmental knowledge, travel behavior, travel mode to school, travel mode evaluation, environmental information acquisition and respondent's personal and household information. It takes 20-30 minutes to complete.

Tentative Stages and Dates

1. Pilot in 1~2 classes: September, 2011
2. Full implementation in 90 classes: October 2011

UBC Behavioral Research Ethical Board (BREB) Approval

The UBC BREB has conditionally approved our research proposal (the certificate is attached with this application). The condition is that VSB approves the research as well.

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Extensions

1. **Parents' version of the survey**

The current questionnaire is targeted at students. One natural extension is to test the environmental attitude and knowledge of parents of the youth who complete the questionnaire, who are one of most important source of information for students. The ideal date of implementation will be right after the student survey, say in November. Or we can implement the students and parents' surveys together in October: students complete the survey in school and then bring the adult version of the questionnaire home for their parents to fill in.

2. **Longitudinal survey across years**

Our long term plan is to monitor student's environmental knowledge and attitude over time so that we can track the evolution or progress students make during their high school education. Ideally we would like to work with VSB to formalize this environmental program in VSB schools on an annual basis.

3. **Social network analysis of the peer effects**

The interactions with peers are another important contributor to student's environmental attitudes. This extension needs the information on students' peers. We have developed questionnaires that can help students identify their peers or friends, with whom they interact the most.

Attachment

1. UBC BREB Conditional Approval Certificate
2. Full Questionnaire
3. Consent form for Parents
4. Assent form for Students

1. Environmental Attitudes and Behavior

1. Have you ever changed your travel behavior because of the concern of the environment?

◯ Yes ◯ No

2. Have you ever encouraged other people to change his/her travel behavior because of the concern of the environment?

◯ Yes ◯ No

3. Listed below are statements on environmental attitudes. For each one, please indicate whether you STRONGLY AGREE, MILDLY AGREE, NEUTRAL, MILDLY DISAGREE or STRONGLY DISAGREE.

	Strongly Agree	Mildly Agree	Neutral	Mildly Disagree	Strongly Disagree
Being environmentally responsible is important to me	◯	◯	◯	◯	◯
For the sake of the environment, car users should pay higher taxes	◯	◯	◯	◯	◯
The government shouldn't force people to change in order to protect the environment	◯	◯	◯	◯	◯
We should not have to bring inconvenience to our daily lives in order to protect the environment	◯	◯	◯	◯	◯
The government should raise the price of gasoline to reduce congestion and air pollution	◯	◯	◯	◯	◯
It is important to build more roads to reduce congestion even if it will increase pollution	◯	◯	◯	◯	◯
We should reduce car usage to reduce pollution	◯	◯	◯	◯	◯
I do not need to protect the environment if people around me do not pay attention to the environment	◯	◯	◯	◯	◯
The government should encourage the use of cars in the city to stimulate economic growth through increase in consumption	◯	◯	◯	◯	◯
In order to protect the environment, I would cycle and walk more, because these mode do not pollute	◯	◯	◯	◯	◯
In the current state of Canada, economic development is more important than the protection of the environment	◯	◯	◯	◯	◯
The Government should provide incentives to people who travel by electric vehicles, public transport, bicycle or on foot	◯	◯	◯	◯	◯
Purchase and use of private cars is freedom of choice, I will buy and use even if it will damage the environment	◯	◯	◯	◯	◯
The government should take more lead in protecting the environment, even if people don't like it	◯	◯	◯	◯	◯
The government should legislate on categorizing wastes into recyclable categories	◯	◯	◯	◯	◯

2. Environmental Assessment and Knowledge

1. How serious are the environmental problems in Vancouver?

◯ Very Serious ◯ Serious ◯ Not Serious ◯ No Problem

2. How serious is the pollution caused by traffic in Vancouver?

◯ Very Serious ◯ Serious ◯ Not Serious ◯ No Problem

3. Which of the following transportation method create the least pollution?

◯ Bus ◯ Train ◯ Cycling ◯ Car

4. Clothes Washing powder causes water pollution mainly because it contains:

◯ Chlorine ◯ Nitrogen ◯ Phosphorus ◯ Potassium

5. The carbon of "carbon emissions" refers to:

◯ Carbon monoxide ◯ Carbon dioxide ◯ Coal ◯ Carbohydrate

6. What percentage of the world total CO2 emission does transport sector account for?

◯ 2% ◯ 25% ◯ 50% ◯ 90%

7. Which of the following statement about ecological footprint is not correct?

◯ The ecological footprint is a measure of human demand on the Earth's ecosystems.

◯ It represents the amount of biologically productive land and sea area needed to regenerate the resources a human population consumes and to absorb and render harmless the corresponding waste.

◯ Although present human life style continues to increase the ecology footprint, the total is still within Earth's bearing capacity

◯ Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle.

8. "Biodiversity"means:

◯ Each living thing has many characteristics

◯ Each kind of living thing has many varieties

◯ Organic food has many varieties

◯ Diversity of Biological species, ecosystem and gene multiplicity

9. Which of the following statements about greenhouse effect is incorrect?

◯ The greenhouse effect is caused by greenhouse gases selective absorption of radiation which results in rise of surface temperature

◯ The main greenhouse gas is carbon dioxide

◯ Increased concentration of carbon dioxide in recent decades is a natural occurring process, not as a result of human activity.

◯ Current atmospheric CO2 concentration is increasing rapidly, while the increase of greenhouse gases cause global warming

10. Which of the following type of fuel produce the most carbon dioxide emissions?

- ◯ Compressed Natural Gas
- ◯ Ethanol
- ◯ Petroleum-based fossil-fuels
- ◯ Bio-diesel

11. Which of the following waste materials can not be recycled?

- ◯ Waste paper, waste plastic
- ◯ Expired drugs
- ◯ Glass, metal
- ◯ Fabric

12. Which of the following strategy does not reduce CO2 emission in urban transport?

- ◯ Use alternative fuel vehicle
- ◯ Limit car ownership and usage
- ◯ Improve fuel economy
- ◯ Reduce public transportation services

13. "Organic food " means:

- ◯ Food with no environmental impact
- ◯ Food produced without using synthetic pesticides, hormones, food additives and other production
- ◯ Uncontaminated food
- ◯ Food produced using genetic modification

14. Which country is the world's largest oil consumer?

- ◯ United States
- ◯ China
- ◯ Japan
- ◯ Canada

15. Which of the following transport sector has the highest energy consumption in Canada?

- ◯ Railways
- ◯ Highways
- ◯ Waterways
- ◯ Aviation

16. What percentage of British Columbia's greenhouse gas emissions come from Metro Vancouver cars?

- ◯ 50%
- ◯ 35%
- ◯ 25%
- ◯ 10%

3. Travel to School

1. What is the distance between your home and school? (kilometers)

- ◯ less than 0.25km
- ◯ 0.25-0.5km
- ◯ 0.5-1km
- ◯ 1-2km
- ◯ 2-5km
- ◯ more than 5km

2. What was your one-way commuting time to school yesterday (in minutes)?

3. What would be your ideal one-way commuting time to school? (minutes)

- ◯ 5
- ◯ 10
- ◯ 15
- ◯ 20
- ◯ 30
- ◯ 40
- ◯ 60

4. Do you travel to school with a companion?

- ◯ By myself
- ◯ With classmates
- ◯ With my parents/guardians
- ◯ With my siblings
- ◯ Other

5. What was the primary travel mode for your morning commute to school yesterday?

- ◯ Car Driver
- ◯ Car Passenger
- ◯ Public Transit
- ◯ School Bus
- ◯ Taxi
- ◯ Walk
- ◯ Bike
- ◯ Other

6. What did you do after you leave school yesterday?

- ◯ Go Home
- ◯ Personal Business (e.g., bank, dentist)
- ◯ Recreational/Social (e.g., movie, sport)
- ◯ Dining/Restaurant
- ◯ Shopping
- ◯ Work
- ◯ Other

7. Which was your main mode of transport after you leave school yesterday?

- ◯ Car Driver
- ◯ Car Passenger
- ◯ Public Transit
- ◯ School Bus
- ◯ Taxi
- ◯ Walk
- ◯ Bike
- ◯ Other

8. What was the commuting time to your after school activity yesterday (in minutes)?

9. How often on average do you use each of the following travel modes?

	6-7 days a week	5 days a week	3-4 days a week	1-2 days a week	once a fortnight	once a month	less often	never
Walk	◯	◯	◯	◯	◯	◯	◯	◯
Bike	◯	◯	◯	◯	◯	◯	◯	◯
Public Transit Buses	◯	◯	◯	◯	◯	◯	◯	◯
School Buses	◯	◯	◯	◯	◯	◯	◯	◯
Sky Train / Commuter Rail	◯	◯	◯	◯	◯	◯	◯	◯
Taxi	◯	◯	◯	◯	◯	◯	◯	◯
Car Driver	◯	◯	◯	◯	◯	◯	◯	◯
Car Passenger	◯	◯	◯	◯	◯	◯	◯	◯

10. Who decide how you travel to school (i.e. which travel mode to use)?

- ◯ Myself
- ◯ Parents / Guardian

11. What are the factors that influence your current travel mode choice to school?

- ☐ Cost
- ☐ Convenient
- ☐ Road Safety
- ☐ Reliable
- ☐ Environmental
- ☐ Personal Safety
- ☐ Comfortable
- ☐ Health
- ☐ Social

12. How would you rate the safety level of your daily commute to school?

- ◯ Very Safe
- ◯ Safe
- ◯ Unsafe
- ◯ Very unsafe

13. If you were free to choose any mode of transport to and from school, what is the ideal mode you would choose?

- ◯ Walk
- ◯ Car Driver
- ◯ Bike
- ◯ Public Transit
- ◯ Car Passenger
- ◯ Other
- ◯ School Bus
- ◯ Taxi

4. Personal and Household Information

1. Your gender

- ◯ Male
- ◯ Female

2. Your grade

- ◯ 8
- ◯ 9
- ◯ 10
- ◯ 11
- ◯ 12

3. What is your name?

4. What is your home postal code?

5. How many cars does your household own?

- ◯ 0
- ◯ 1
- ◯ 2
- ◯ 3 or more

6. Do you have your own car?

- ◯ Yes
- ◯ No

7. What is your household annual income before taxes?

- ◯ Less than $25,000
- ◯ $25,000 to $49,999
- ◯ $50,000 to $74,999
- ◯ $75,000 to $99,999
- ◯ $100,000 to $149,999
- ◯ $150,000 and over

8. Number of household members

9. Number of children in your household (18 years or younger)

10. Number of household members with driver licenses

11. Do you have a driver license?

- ◯ Yes
- ◯ No

12. What is your home dwelling type?

- ◯ House
- ◯ Duplex
- ◯ Townhouse
- ◯ Low Rises
- ◯ High Rises

Other (please specify)

13. What is the tenure of your home?

- ◯ Own
- ◯ Rent
- ◯ Other

14. How long have you been living in your current home?

- ◯ less than 3 months
- ◯ 3 months to 1 year
- ◯ 1 year to 3 years
- ◯ 3 years to 5 years
- ◯ more than 5 years

15. What is your e-mail address?

Appendix B: One way ANOVA of Environmental Knowledge and Attitudes by socioeconomic status

APPENDIX B: One way ANOVA of Environmental Knowledge and Attitudes by socioeconomic status

ANOVA of GENKNOW

		Sum of Squares	df	Mean Square	F	P-Value	F crit	Significant
Gender	Between Groups	0.7	1	0.66	0.22	0.64	3.85	No
	Within Groups	2590.6	860	3.01				
	Total	2591.2	861					
Grade	Between Groups	22.4	4	5.59	1.84	0.12	2.38	No
	Within Groups	2610.3	860	3.04				
	Total	2632.7	864					
Income	Between Groups	5.6	2	2.82	0.91	0.40	3.02	No
	Within Groups	1346.4	434	3.10				
	Total	1352.0	436					
HouseCar	Between Groups	2.7	3	0.89	2.37	0.07	2.62	No
	Within Groups	295.9	791	0.37				
	Total	298.5	794					
DriveLic	Between Groups	12.3	1	12.25	4.04	0.04	3.85	Yes
	Within Groups	2576.7	849	3.03				
	Total	2588.9	850					
Residency	Between Groups	11.2	2	5.61	1.86	0.16	3.01	No
	Within Groups	2557.1	850	3.01				
	Total	2568.3	852					
HousePpl	Between Groups	17.4	4	4.36	1.48	0.21	2.38	No
	Within Groups	2412.1	817	2.95				
	Total	2429.5	821					
HouseLic	Between Groups	17.0	4	4.24	1.44	0.22	2.38	No
	Within Groups	2418.0	823	2.94				
	Total	2435.0	827					
Children	Between Groups	10.4	4	2.61	0.88	0.48	2.38	No
	Within Groups	2454.1	826	2.97				
	Total	2464.6	830					
OwnCar	Between Groups	51.4	1	51.44	17.33	0.00	3.85	Yes
	Within Groups	2562.3	863	2.97				
	Total	2613.8	864					
Dwelling	Between Groups	12.6	4	3.14	1.04	0.39	2.38	No
	Within Groups	2434.1	806	3.02				
	Total	2446.7	810					
YearHome	Between Groups	44.6	4	11.16	3.73	0.01	2.38	Yes
	Within Groups	2534.3	847	2.99				
	Total	2578.9	851					

ANOVA of TRANKNOW

		Sum of Squares	df	Mean Square	F	P-Value	F crit	Significant
Gender	Between Groups	0.8	1	0.84	0.56	0.46	3.85	No
	Within Groups	1289.0	860	1.50				
	Total	1289.8	861					
Grade	Between Groups	6.7	4	1.68	1.12	0.35	2.38	No
	Within Groups	1291.0	860	1.50				
	Total	1297.7	864					
Income	Between Groups	3.7	2	1.83	1.22	0.30	3.02	No
	Within Groups	652.3	434	1.50				
	Total	655.9	436					
HouseCar	Between Groups	1.4	3	0.46	1.27	0.28	2.62	No
	Within Groups	286.3	791	0.36				
	Total	287.7	794					
DriveLic	Between Groups	1.5	1	1.51	1.00	0.32	3.85	No
	Within Groups	1274.3	849	1.50				
	Total	1275.8	850					
Residency	Between Groups	8.8	2	4.39	2.94	0.05	3.01	No
	Within Groups	1269.2	850	1.49				
	Total	1278.0	852					
HousePpl	Between Groups	24.0	4	5.99	4.12	0.00	2.38	Yes
	Within Groups	1187.9	817	1.45				
	Total	1211.8	821					
HouseLic	Between Groups	9.0	4	2.24	1.52	0.19	2.38	No
	Within Groups	1210.3	823	1.47				
	Total	1219.3	827					
Children	Between Groups	16.5	4	4.13	2.81	0.02	2.38	Yes
	Within Groups	1211.2	826	1.47				
	Total	1227.7	830					
OwnCar	Between Groups	8.1	1	8.10	5.38	0.02	3.85	Yes
	Within Groups	1298.8	863	1.50				
	Total	1306.9	864					
Dwelling	Between Groups	12.2	4	3.05	2.01	0.09	2.38	No
	Within Groups	1222.7	806	1.52				
	Total	1234.9	810					
YearHome	Between Groups	14.7	4	3.67	2.46	0.04	2.38	Yes
	Within Groups	1261.3	847	1.49				
	Total	1276.0	851					

ANOVA of GENATT

		Sum of Squares	df	Mean Square	F	P-Value	F crit	Significant
Gender	Between Groups	0.0	1	0.01	0.03	0.86	3.85	No
	Within Groups	300.6	796	0.38				
	Total	300.6	797					
Grade	Between Groups	1.3	4	0.33	0.89	0.47	2.38	No
	Within Groups	299.4	798	0.38				
	Total	300.7	802					
Income	Between Groups	2.5	2	1.25	3.58	0.03	3.02	Yes
	Within Groups	141.8	405	0.35				
	Total	144.3	407					
HouseCar	Between Groups	2.7	3	0.89	2.37	0.07	2.62	No
	Within Groups	295.9	791	0.37				
	Total	298.5	794					
DriveLic	Between Groups	2.6	1	2.64	7.26	0.01	3.85	Yes
	Within Groups	285.9	785	0.36				
	Total	288.5	786					
Residency	Between Groups	0.4	2	0.18	0.49	0.61	3.01	No
	Within Groups	292.5	788	0.37				
	Total	292.9	790					
HousePpl	Between Groups	2.1	4	0.52	1.39	0.23	2.38	No
	Within Groups	280.5	754	0.37				
	Total	292.9	790					
HouseLic	Between Groups	1.1	4	0.27	0.73	0.57	2.38	No
	Within Groups	285.9	760	0.38				
	Total	287.0	764					
Children	Between Groups	2.1	4	0.52	1.40	0.23	2.38	No
	Within Groups	284.2	761	0.37				
	Total	286.3	765					
OwnCar	Between Groups	0.5	1	0.52	1.38	0.24	3.85	No
	Within Groups	300.6	797	0.38				
	Total	301.1	798					
Dwelling	Between Groups	1.1	4	0.28	0.74	0.56	2.38	No
	Within Groups	284.4	748	0.38				
	Total	285.5	752					
Duration	Between Groups	1.0	4	0.25	0.69	0.60	2.38	No
	Within Groups	289.9	788	0.37				
	Total	290.9	792					

ANOVA of TRANATT

		Sum of Squares	df	Mean Square	F	P-Value	F crit	Significant
Gender	Between Groups	1.1	1	1.06	2.91	0.09	3.85	No
	Within Groups	289.1	796	0.36				
	Total	290.2	797					
Grade	Between Groups	2.6	4	0.64	1.78	0.13	2.38	No
	Within Groups	286.5	798	0.36				
	Total	289.0	802					
Income	Between Groups	1.1	2	0.54	1.48	0.23	3.02	No
	Within Groups	149.3	405	0.37				
	Total	150.4	407					
HouseCar	Between Groups	0.9	1	0.93	2.84	0.09	3.85	No
	Within Groups	248.2	758	0.33				
	Total	249.1	759					
DriveLic	Between Groups	0.2	1	0.17	0.48	0.49	3.85	No
	Within Groups	279.1	785	0.36				
	Total	279.3	786					
Residency	Between Groups	1.2	2	0.59	1.67	0.19	3.01	No
	Within Groups	279.3	788	0.35				
	Total	280.5	790					
HousePpl	Between Groups	2.1	4	0.52	1.46	0.21	2.38	No
	Within Groups	269.1	754	0.36				
	Total	271.2	758					
HouseLic	Between Groups	3.8	4	0.94	2.62	0.03	2.38	Yes
	Within Groups	272.6	760	0.36				
	Total	276.4	764					
Children	Between Groups	0.2	4	0.05	0.15	0.96	2.38	No
	Within Groups	272.1	761	0.36				
	Total	272.3	765					
OwnCar	Between Groups	1.1	1	1.09	3.06	0.08	3.85	No
	Within Groups	283.9	797	0.36				
	Total	285.0	798					
Dwelling	Between Groups	0.9	4	0.23	0.64	0.63	2.38	No
	Within Groups	268.3	748	0.36				
	Total	269.3	752					
YearHome	Between Groups	0.3	4	0.07	0.19	0.94	2.38	No
	Within Groups	282.4	788	0.36				
	Total	282.7	792					

Appendix C: Measurement Equation for the Latent Variables

APPENDIX C: MEASUREMENT EQUATIONS FOR THE LATENT VARIBLES

Model 1a: STUDENT-DECISION-MAKER

	Latent Factors	
	ENVATT	
Measured by	Estimate	Est./S.E.
x1	0.520	15.7
x4	0.413	11.7
x8	0.605	18.8
x11	0.445	12.1
x3	0.371	10.0
x14	0.597	18.4
x15	0.381	10.3
x6	0.373	10.8
x7	0.514	15.3
x10	0.561	17.5
x13	0.445	12.7
x2	0.481	13.5
x5	0.345	8.8
x12	0.376	10.5

Model 1a: PARENT-DECISION-MAKER

	Latent Factors	
	ENVATT	
Measured by	Estimate	Est./S.E.
x1	0.551	14.7
x4	0.412	10.4
x8	0.625	16.7
x11	0.428	11.7
x3	0.358	9.3
x14	0.610	16.6
x15	0.376	9.5
x6	0.416	10.1
x7	0.525	14.3
x10	0.563	15.6
x13	0.481	12.8
x2	0.512	13.0
x5	0.368	8.7
x12	0.394	10.0

Model 1b: STUDENT-DECISION-MAKER

	Latent Factors			
	GENATT		TRANATT	
Measured by	Estimate	Est./S.E.	Estimate	Est./S.E.
x1	0.511	15.1	n.a.	
x4	0.428	12.1	n.a.	
x8	0.620	18.4	n.a.	
x11	0.454	12.3	n.a.	
x3	0.373	9.9	n.a.	
x14	0.608	17.1	n.a.	
x15	0.389	10.3	n.a.	
x6	n.a.		0.374	10.4
x7	n.a.		0.550	16.0
x10	n.a.		0.600	18.1
x13	n.a.		0.465	12.9
x2	n.a.		0.490	13.1
x5	n.a.		0.375	9.4
x12	n.a.		0.372	9.7

Model 1b: PARENT-DECISION-MAKER

	Latent Factors			
	GENATT		TRANATT	
Measured by	Estimate	Est./S.E.	Estimate	Est./S.E.
x1	0.559	14.6	n.a.	
x4	0.446	10.7	n.a.	
x8	0.670	16.9	n.a.	
x11	0.454	11.9	n.a.	
x3	0.375	9.3	n.a.	
x14	0.643	16.2	n.a.	
x15	0.400	9.6	n.a.	
x6	n.a.		0.413	9.7
x7	n.a.		0.572	14.2
x10	n.a.		0.604	15.6
x13	n.a.		0.505	12.8
x2	n.a.		0.519	12.8
x5	n.a.		0.402	9.1
x12	n.a.		0.388	9.3

Appendix D: Interview Questions

APPENDIX D: INTERVIEW QUESTIONS

Questions for Sustainable Coordinators

1. Explain your position and the role you play in environmental education.
2. How well do you think environmental education is included in the curriculum?
3. Are there currently any mandatory courses in high school that relate to environmental studies?
4. What are some of the "outside the classroom" activities?
5. The Environmental Learning and Experience Curriculum Map /Guide assist BC teachers to integrate environmental concepts into teaching and learning. Is it mandatory or voluntary for the teachers to follow the guide?
6. Any schools are offering sustainability course? In the sustainability course guide, one of the modules is on sustainable design and transportation. Do you know which school is currently teaching that topic?
7. Are teachers being introduced to sustainability education? Is there training for the teachers?
8. How the teachers integrate environmental education into their practice? Are there any tools, guides and resources for the teachers to use?
9. What are some of the plans to advance sustainability education? Are there any plans to teach the students more on sustainable transportation?
10. What are some of the obstacles to environmental education in Vancouver schools?
11. What organizations are working with the school board?
12. What is the source of funding for the environmental education program?

Questions for Teachers

1. At what school do you teach?
2. What grade(s) do you teach?
3. What subject(s) do you teach?
4. Do you incorporate environmental education in your lessons?
5. How often do you incorporate environmental education into your lessons?
6. Do you teach topics related to the environment and transportation?
7. Can you explain what you teach / cover in your course(s) on the environment and transportation?
8. Have you ever encouraged your students to become environmentally responsible?

9. Have you ever encouraged your students to use sustainable transport?
10. Of the environmental education you incorporate into your lessons, how much of it is based on the curriculum and how much is your own initiative?
11. What techniques do you use to help your students learn about the environment?
12. What resources do you use and how do you use them?
13. How well do you think environmental education is included in the curriculum?
14. What do you think is the most effective way to include environmental education in the classroom? What tools would be helpful?
15. What are the obstacles to incorporate environmental education in BC schools?
16. What are your opinions on improving environmental education in BC?
17. Are you aware of the 2007 "Environmental Learning and Experience Guide" distributed by the BC Ministry of Education?
18. How useful do / did you find this document?
19. Should British Columbia develop policy on incorporating environmental education in the schools?
20. Have you personally been involved in any of the following environmental activities?

Appendix E: Sample MPLUS Code

APPENDIX E: SAMPLE MPLUS CODE

```
TITLE: Environmental Knowledge and Attitudes

DATA: FILE IS EnvAtt.txt;

VARIABLE:

    NAMES ARE
    CollID  StudID   x1-x61
    Male Grade HouseCar OwnCar Income HousePpl
    Children HouseLic DriLic Dwelling
    Tenure YearHome
    Know GenKnow TranKnow
    SchDri SchPass SchTran SchBus SchTaxi
    SchWalk SchBike SchOth SchCar SchTB SchWB;

    Missing are All (-9999);

    USEVARIABLES are

    x3 x4 x5 x6 x7 x8 x9
    x10 x12 x13 x14
    x15 x16 x17
    Male Grade OwnCar HousePpl
    Children HouseLic DriLic GenKnow TranKnow YearHome
    Duplex Townhous LowRise HighRise Rent
    LowIn HighIn;

 DEFINE:

        x5=6-x5;
        x6=6-x6;
        x8=6-x8;
        x10=6-x10;
        x13=6-x13;
        x15=6-x15;
        Duplex = (Dwelling == 2);
        Townhous = (Dwelling == 3);
        LowRise = (Dwelling == 4);
        HighRise = (Dwelling == 5);
        Rent = (Tenure == 1);
        LowIn = (Income <=3);
        HighIn = (Income >=5 AND Income <=6);
```

```
ANALYSIS:

    PROCESSORS=8;

MODEL:

    GenAtt BY x3 x6 x10 x13 x5 x16 x17;
    TranAtt BY x8 x9 x12 x15 x4 x7 x14;
    GenAtt TranAtt GenKnow TranKnow ON Male Grade OwnCar
    HousePpl Children HouseLic DriLic YearHome Duplex Townhous LowRise
    HighRise Rent LowIn HighIn;
    GenKnow WITH TranKnow;
    GenAtt TranAtt ON GenKnow TranKnow;
    GenAtt WITH TranAtt;
    x7 with x4 x9;
    x6 with x5;
    x13 with x15 x8;
    x17 with x16;
    x10 with x4 x7 x16;
    x3 with x12 x4;

MODEL INDIRECT:

   GenAtt IND Male;
   GenAtt IND OwnCar;
   GenAtt IND Duplex;
   TranAtt IND Male;
   TranAtt IND Grade;
   TranAtt IND HighIn;

OUTPUT:

     TECH4 MODINDICES SAMPSTAT STANDARDIZED;
```

```
TITLE: Environmental Attitudes and Travel Behavior

DATA:

  FILE IS EnvAtt.txt;

VARIABLE:

  NAMES ARE
```

```
  CollID  StudID x1-x41 Walk Bike Tran Bus Train
  Taxi Driver Pass x50-x61
  Male Grade HouseCar OwnCar Income HousePpl
  Children HouseLic DriLic Dwelling
  Tenure YearHome
  Know GenKnow TranKnow
  SchDri SchPass SchTran SchBus SchTaxi
  SchWalk SchBike SchOth SchCar SchTB SchWB
  AftDri AftPass AftTran AftBus AftTaxi
  AftWalk AftBike AftOth AftCar AftTB AftWB;

  Missing are All (-9999);

  USEVARIABLES are
  x3 x4 x5 x6 x7 x8 x9
  x10 x12 x13 x14
  x15 x16 x17
  Male Grade HouseCar OwnCar HousePpl
  Children HouseLic DriLic YearHome SchWB SchTB
  Duplex Townhous LowRise HighRise Rent
  LowIn HighIn ;

  GROUPING Is x50 (1=student 2=parent);

DEFINE:

      x5=6-x5;
      x6=6-x6;
      x8=6-x8;
      x10=6-x10;
      x13=6-x13;
      x15=6-x15;
      Duplex = (Dwelling == 2);
      Townhous = (Dwelling == 3);
      LowRise = (Dwelling == 4);
      HighRise = (Dwelling == 5);
      Rent = (Tenure == 1);
      LowIn = (Income <=3);
      HighIn = (Income >=5 AND Income <=6);
```

```
ANALYSIS:

    PROCESSORS=8;

MODEL:

    EnvAtt BY x3 x6 x10 x13 x5 x16 x17 x8 x9 x12 x15 x4 x7 x14;
    EnvAtt SchWB SchTB ON Male Grade HouseCar OwnCar
    HousePpl Children HouseLic DriLic YearHome Duplex Townhous LowRise
    HighRise Rent LowIn HighIn;
    EnvAtt ON SchWB SchTB;
    x7 with x4 x9;
    x6 with x5;
    x13 with x15 x8;
    x16 with x17;
    x10 with x4 x7 x16;
    x3 with x12 x4;

MODEL INDIRECT:

    EnvAtt IND Male;
    EnvAtt IND Grade;
    EnvAtt IND HouseCar;
    EnvAtt IND OwnCar;
    EnvAtt IND HousePpl;
    EnvAtt IND Children;
    EnvAtt IND HouseLic;
    EnvAtt IND DriLic;
    EnvAtt IND YearHome;
    EnvAtt IND Duplex;
    EnvAtt IND TownHous;
    EnvAtt IND LowRise;
    EnvAtt IND HighRise;
    EnvAtt IND Rent;
    EnvAtt IND LowIn;
    EnvAtt IND HighIn;


OUTPUT:

    TECH4 MODINDICES SAMPSTAT STANDARDIZED;
```

```
TITLE: Environmental Knowledge, Attitudes and Travel Behavior

DATA:

   FILE IS EnvAtt.txt;

VARIABLE:

   NAMES ARE
   CollID  StudID x1-x61
   Male Grade HouseCar OwnCar Income HousePpl
   Children HouseLic DriLic Dwelling
   Tenure YearHome
   Know GenKnow TranKnow
   SchDri SchPass SchTran SchBus SchTaxi
   SchWalk SchBike SchOth SchCar SchTB SchWB
   AftDri AftPass AftTran AftBus AftTaxi
   AftWalk AftBike AftOth AftCar AftTB AftWB;

   Missing are All (-9999);

   USEVARIABLES are

   x3 x4 x5 x6 x7 x8 x9
   x10 x12 x13 x14
   x15 x16 x17 Know
   Male Grade HouseCar OwnCar HousePpl
   Children HouseLic DriLic YearHome
   SchTB SchWB
   Duplex Townhous LowRise HighRise Rent
   LowIn HighIn ;

DEFINE:

      x5=6-x5;
      x6=6-x6;
      x8=6-x8;
      x10=6-x10;
      x13=6-x13;
      x15=6-x15;
      Duplex = (Dwelling == 2);
      Townhous = (Dwelling == 3);
      LowRise = (Dwelling == 4);
      HighRise = (Dwelling == 5);
```

```
    Rent = (Tenure == 1);
    LowIn = (Income <=3);
    HighIn = (Income >=5 AND Income <=6);

ANALYSIS:

    PROCESSORS=8;

MODEL:

    EnvAtt BY x3 x6 x10 x13 x5 x16 x17 x8 x9 x12 x15 x4 x7 x14;
    EnvAtt SchTB SchWB Know ON Male
    Grade HouseCar OwnCar HousePpl Children HouseLic
    DriLic YearHome Duplex Townhous LowRise HighRise Rent LowIn HighIn;
    SchTB SchWB on EnvAtt;
    EnvAtt on Know;
    x7 with x4 x9;
    x6 with x5;
    x13 with x15 x8;
    x16 with x17;
    x10 with x4 x7 x16;
    x3 with x12 x4;

OUTPUT:

    TECH4 MODINDICES SAMPSTAT STANDARDIZED;
```