Children’s Ideas
About Climate Change

By

Elise Ho

A thesis submitted in conformity with the requirements for the degree of
Doctor of Philosophy
Department of Geography and
Collaborative Program in Environmental Studies
University of Toronto

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Abstract

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This thesis examines children’s (aged 11-12) ideas about climate change. Seventh grade children in 9 schools in Ontario were interviewed and submitted illustrated responses about climate change over a one year period of data collection. Qualitative grounded theory was used to allow themes from the data to emerge, and the use of computer software, NVivo7, was used to code and classify themes. The data were analyzed to answer three main research questions. First, the thesis explored if there were common similarities or differences between the children’s and adults’ responses (as gained from the literature). Second, children’s responses were grouped by geographical location. These locations included rural, urban, and suburban school. This was conducted in order to determine if any group differences exist among children in these three areas. The study found that children’s and adults perceptions are quite similar, and that in some situations, both groups tend to use substitution of other environmental knowledge (cultural models) in lieu of knowledge of climate change but that children also tended to use different cultural models to explain their ideas about climate change. The thesis concluded that no group differences existed among rural, urban, and suburban children and children in all groups tended to have much more detailed knowledge of mitigation strategies than the effects and causes of climate change. The thesis also concluded that a new educational framework, modeled after the Causes, Effects, and Mitigation Strategies of Climate Change (CEM Framework) ought to be used to redistribute this knowledge across these three areas.
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# Table of Contents

List of Tables viii  
List of Figures ix  
1. Introduction 1  
   1.1 Climate Change and Children’s Ideas about Climate Change 1  
   1.2 Purpose of Study and Research Questions 5  
2. Literature Review 9  
   2.1 Adults’ Perceptions of Environment and Climate Change 10  
      2.1.1 Public Perceptions of Climate Change ..................................................... 10  
   2.2 Climate Change Risk Communication 16  
   2.3 Children’s Perceptions 20  
      2.3.1 Children and the Environment ................................................................. 20  
      2.3.2 Children’s Perceptions of Environmental Risks ....................................... 23  
      2.3.3 Children’s Perceptions of Climate Change ............................................... 25  
   2.4 Place and Perceptions 28  
   2.5 Methodological Considerations 30  
      2.5.1 Questionnaires and Interviews with Children in Climate Change Studies 30  
      2.5.2 Illustrations as a Method in Qualitative Research .................................. 33  
      2.5.3 Grounded Theory as a Research Approach .............................................. 35  
   2.6 Summary of the Literature 37  
3. Methodology 41  
   3.1 Overview of Methodology 41
3.1.1 Research Bias, Judgments and Autobiography ........................................... 42

3.2 Detailed Methodology .................................................................................. 45

3.2.1 Research Context and Study Areas ......................................................... 45
3.2.2 Confidentiality ....................................................................................... 47
3.2.2 Illustrated Responses .............................................................................. 48
3.2.3 Open Ended Interviews ....................................................................... 49
3.3 Description of Data Analysis ................................................................... 51

4. Research Results and Discussion .................................................................. 61

4.1 Illustrated Responses .................................................................................. 62

4.1.1 General Themes of Climate Change from Children’s Illustrations .......... 62

4.2 Open-Ended Interviews ........................................................................... 79

4.2.1 Summary of Major Themes from Open-Ended Interviews ................. 80

4.3 Place and Students’ Ideas about Climate Change ....................................... 119

4.5 Qualitative Methods to Assess Children’s Ideas about Climate Change .... 122

4.5 Relevance of Results for an Educational Framework for Elementary Climate Change Curriculum .......................................................... 125

5. Conclusion and Recommendations ............................................................... 131

5.1 Main Research Questions ......................................................................... 131

5.1.1 Children’s Perceptions of Climate Change and Climate Risks .......... 132
5.1.2 Place and Perception: Differences between Urban, Suburban, and Rural Students’ Perceptions of Climate Change .............................................. 133
5.1.3 Children’s and Adults’ Ideas about Climate Change ............................ 133
5.1.4 A CEM Framework for Climate Change Education .............................. 135
5.1.5 Illustrations as a Method of Understanding Children’s Ideas about Climate Change .................................................................................. 136
5.2 Suggestions for Further Research 139

Bibliography 141

Appendices 152
List of Tables

Table 1: Open-Ended Interview Questions for Students in the 7th Grade ................................. 50

Table 2: Illustrations of Climate Change Grouped by Thematic Response: Frequency by Area. 63

Table 3: Descriptions of the Greenhouse Effect: Frequency by School Area .............................. 81

Table 4: Students’ Familiarity with the term “Climate Change”: Frequency by School Area..... 84

Table 5: Students’ Initial Ideas about Climate Change: Frequency by Area ............................. 90

Table 6: Students’ Ideas about the causes of Climate Change: Frequency by Area .................. 96

Table 7: Ideas about the Impacts of Climate Change: Frequency by Area .............................. 102

Table 8: Ideas about Climate Change Mitigation Strategies: Frequency by Area ...................... 107

Table 9: P-Values for Differences between Urban, Rural, and Suburban Students’ Illustrated Responses to “What does Climate Change mean to you?” ......................................................... 119

Table 10: P-Values for Differences between Urban, Rural, and Suburban Students’ Responses to Open-Ended Interviews .............................................................................................................. 120
List of Figures

Figure 1 - Overview of Research Methodology ................................................................. 42

Figure 2 – An example of an illustration of climate change, showing the use of words to help describe their illustration.................................................................................. 59

Figure 3 - A rural student’s illustration of “weather change”, depicting changes from high to low temperature, cold to warm clothing, and sunny to stormy conditions ........................................... 64

Figure 4 - A suburban student’s illustration of “climate change”, depicting changes in weather from sunny, to stormy, and back to sunny again ......................................................... 65

Figure 5 - A suburban students’ illustration of a tree across the four seasons of winter, spring, summer, and fall ............................................................................................................ 67

Figure 6 - An urban student’s illustration depicting various activities and weather changes associated with the four seasons ................................................................................................ 68

Figure 7 – A rural student’s illustration of several aspects of “climate change”, including a politician, migrating diseases, increased temperatures, polar ice melt, greenhouse gas emissions and the displacement of wildlife. ................................................................. 71

Figure 8 – A suburban student’s illustration of children expressing disbelief over atypical weather events, including a fast change from snowy to sunny conditions, snowfall in the summer and a thunderstorm with no rain ........................................................................... 73
Figure 9 - A suburban student’s illustration of general climate knowledge, depicting the rotation of the earth in relation to the sun. .................................................................................................................. 74

Figure 10 – An urban student’s illustration topographical influences on weather variations ...... 75

Figure 11 - An urban student’s illustration of “pollution”, depicting weather-related events, a factory, and human-made missiles or bombs.................................................................................................................. 77

Figure 12 – A rural student’s illustration of “pollution” depicting a nuclear factory, “The Bay”, and a factory.................................................................................................................................................. 78

Figure 13 – An urban student’s illustration of “climate change”, who stated that he did not know what climate change was, when asked in an open-ended interview .................................................. 87

Figure 14 - Types of Responses from Open-Ended Interviews.................................................. 113

Figure 15 – Conceptual Representation of Children’s Familiarity with Climate Change Information ............................................................................................................................................... 126

Figure 16 – A CEM Framework for Climate Change Education .................................................. 127
1. Introduction

1.1 Climate Change and Children’s Ideas about Climate Change

This thesis examines how children understand climate change. Climate change can be thought of in two ways. The first is as an environmental issue, and the second is as a scientific field of study. Climate change, as a scientific definition, is a change in the long term average weather variables in a certain region, and also changes to year-to-year variation of weather variables in that region (Harvey 2000: 8). Throughout earth’s history, regional and global climates have changed due to natural factors, such as changes in radiative forcing and Milankovitch cycles.

Climate change as an environmental issue refers to regional and global scale changes in climate due to human activities, in particular the emission of greenhouse gases, which cause changes in the heat balance of our climate (Harvey 2000). This thesis is concerned with climate change as an environmental issue, and in particular, the range of changes that are expected to occur within the next 50-100 years. This time frame is important because it is related to the most common climate change projections, which use a doubling of atmospheric carbon dioxide concentrations as the benchmark of comparison. It is expected that this doubling (in comparison to pre-industrial revolution levels) will occur within the next 50-100 years (IPCC 2001). This will result in a range of climate changes, including increased average global temperatures and changes to precipitation patterns.
With films such as “The Day After Tomorrow” and “An Inconvenient Truth”, and the popularization of climate change as an environmental issue, we have come into an era where “climate change” and “global warming” are household terms and popular phrases. Images of polar bears, smokestacks, melting ice, and power plants have become popularly associated with the climate discourse. This is not to say, however, that the issue of human-induced climate change is clear. Climate change is a diverse and complicated issue for both scientists and members of the public. To say that it is complex is a profound understatement. The interactions between causes and effects and uncertain science all add to the multi-dimensional and oftentimes confusing characteristics of climate change. Climate change is an especially difficult issue because the evidence is often presented to the public in a clouded or even untrue manner, and also individual risk perceptions and ways of thinking can influence public understanding and action (Etkin & Ho 2007).

Climate change is an issue that is often understood differently by the general public and also among scientists (Kempton, 1991, McDaniels et al. 1996, Kempton 1997, O’Conner et al. 1999, Mortsch et al. 2000, Seacrest et al. 2000, Sterman & Sweeney 2002, Leiserowitz 2005). These misconceptions are indicative of inadequate risk communication between scientists and the lay public, which ought to consist of a two-way dialogue, as opposed to a one-way dissemination of information (Leiss & Powell 1997). Climate change risk perception research in this area has focused on determining the root causes of the most common differences between lay public perceptions and scientific consensus of climate change. The rationale for this research is that by identifying such causes, and by identifying the differences themselves, actions may be taken by governments or other agencies to clarify misconceptions so that the public may be better informed of the processes, causes, and appropriate mitigating efforts related to climate change.
change. For example, one of the common misunderstandings is that ozone depletion is a cause of climate change. This can be problematic as efforts concentrated on reducing ozone depletion, in attempts to mitigate climate change, are misguided and also ineffective. The impacts that individual actions have on anthropogenic climate change are also misunderstood, as another common belief is that climate change is caused by “pollution” from industrial sources, as opposed to individual energy consumption. These and other misunderstandings of climate change are explored later in this thesis.

Public perceptions and misconceptions are important to the mobilization of government and individual actions to mitigate anthropogenic climate change. The general public has purchasing power as consumers (Plotnikoff et al. 2004) and voting power to support or oppose political actions regarding climate change issues (Kempton 1997). McDaniels et al. (1996) purport that it will be an informed public, and not reduced scientific uncertainty, which will be the driving force behind necessary climate change actions.

How the public understands, communicates, and manages climate risks will be important issues as climate change continues to gain momentum as the environmental issue of the 21st century. Research on attitudes about and perceptions of climate change has consistently focused on the voting and purchasing public as important actors in climate change. Children have been omitted from this agenda and yet their perceptions are also important to the study of climate change. Children are not often included in academic research (Matthews & Limb 1999), and while they are often studied as subjects in anthropological or psychological research, as actors they are often omitted from academic inquiry. There are three important reasons, however, that children ought to be considered in climate change perception studies. Firstly, they are sentient beings and actors on their own, and so their perceptions and ideas should have value. Secondly,
because they might be affected by climate change in a different way than adults, they ought to be consulted in climate change impact and assessment studies. Their ideas of climate change might be different than adults and without asking them, academic researchers might not be able to understand how climate change affects all groups of people. Their use of space and place is certainly different than their adult counterparts and their perceptions of environment might also be different. As climate change develops into one of the most prevalent and pressing environmental issues of this century, and if we are to plan for future generations' environments, then we ought to look to the next generation for their input. Finally, these children are going to grow into the next generation of the voting and purchasing public, so by understanding their ideas about climate change, we can better educate and inform our incoming cohort of decision-makers. Assessing how children understand climate change will help to understand how educational efforts have addressed this issue and also assess gaps that ought to be filled by future climate change education programs. This thesis seeks to contribute to children’s climate change education programs by understanding what their current ideas about climate change are, and what new ideas or information could enrich their current understanding.

Some researchers argue that children are very important actors in environmental issues and that their perceptions and contributions are integral to true environmental sustainability. While an elusive term to define, environmental sustainability is generally thought of as an approach to development “to ensure that it meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED 1987: 8). With a focus on the welfare of future generations, this next generation of children is integral to sustainability. Chawla (2002a) describes the importance of children to sustainability by drawing on the commitment of the World Commission on Environment and Development (WCED) to children. The WCED states
that children are as important individuals to be in partnership with adults and as a group of people that are increasing in world population. Children’s rights and roles are often downplayed in environmental studies, whereas Chawla (2002a), in partnership with the United Nations, advocates for children as distinct actors in our quest for sustainability. Matthews and Limb (1999) also advocate for the importance of the empowerment of children as competent actors along with adults in the academic fields of environment and geography. Children’s important spaces and places go beyond the playground and the home, and their ideas are more than “child-like” romanticisms and “innocent” experiences (Tuan 1990). Climate change is, in a sense, asking about a present and future environment. Its temporal and broader scales might make it a difficult concept for children (and adults) to grasp, but it will surely affect children’s environments and their spaces. This research seeks to understand how children perceive climate change’s current and future effects on their “world”.

1.2 Purpose of Study and Research Questions

This thesis seeks to understand children’s perceptions of climate change, and to understand if these perceptions are similar to, or different from, adult perceptions of climate change. The implications for this research will be important for climate change research, educational programs, and for the sustainable lifestyles of future generations. Children’s current perceptions of climate change will help to understand if current educational directives are adequately informing students of the causes, effects, and mitigative strategies of climate change.

This research also examines if, and if so how, children’s physical places might influence their perceptions of climate change. Some researchers have examined how rural or urban residents perceive various environmental issues (Lutz et al. 1999, Williams & Cary 2002)
assuming that one’s physical closeness to nature or the built environment can have a great impact on one’s environmental attitudes. Rural residents and urban residents, for example, might have different ideas about wilderness and values about environmental conservation (Lutz et. al 1999). This thesis seeks to understand if place affects children’s attitudes towards climate change, to determine if climate change is felt in the lived environment, and if those perceptions vary from one place to another. In this study, children from urban, suburban, and rural areas of Ontario Canada were asked to share their ideas of climate change through the use of illustrated responses and semi-structured interviews. If differences do exist between these three areas, then educational efforts ought to change, according to area. Presently, the Ontario Educational Curriculum is consistent across the Province. Therefore, this research looks at how children are being educated about climate change as a group in Ontario, and if differences exist among groups of children in different areas.

The main research questions for this thesis are:

1. How do children, aged 11-12, perceive climate change and climate-related risks?
2. Do any differences exist among students in rural, urban, and suburban areas of Ontario, Canada?
3. How do these perceptions and ideas differ from those of adults, as found in the literature?
4. Do these perceptions, similarities, and differences signal a need for a new educational framework for climate change education and if so, what might that framework consist of?
5. What are the merits of qualitative research methodologies, in understanding children’s ideas about climate change? Do less traditional methods, such as illustrations, make a new contribution to research methods with children?
This thesis contributes to a body of knowledge about climate change perceptions and also reinforces the importance of children’s views and ideas in environmental perception studies. Also, some recommendations are made regarding the main gaps in children’s understanding and how educators and governments ought to address these gaps, through a specific educational approach to climate change, to contribute to a better informed public and population of students.

The following chapters include a literature review, a discussion of the methods used in this research, a discussion of the results of the research findings, the conclusions of this thesis and finally, recommendations for further research. The literature review examines four main themes of literature that contribute to the understanding of how children understand climate change. This includes research that examines adult perceptions of climate change, children’s ideas of climate change, the possible effects of place on environmental perceptions, and methodological considerations for doing research with children.

The methodology chapter details the research approaches used in this thesis, including open-ended interviews and the use of illustrated responses to seek out children’s ideas of climate change in rural, urban, and suburban locations.

Chapter 4 includes the data results and discussion of the results, and also compares the results to the ideas and conclusions found from the literature review. These results and discussions are divided into themes. This chapter also discusses the utility of the methodological approaches used and contrasts these to some of the other approaches used by other researchers. In particular, this chapter discusses the utility of illustrative responses as a means of data collection.
The concluding chapter includes the conclusions of this research and answers the main research questions. It also includes recommendations for further research.
2. Literature Review

This chapter summarizes four areas of literature that are important to this research. The first examines adult perceptions of the environment and of climate change, and explains the common themes, or cultural models, that adults tend to use in their understandings of climate change. Much of this research has focused on common differences between adult perceptions of climate change and the overall scientific consensus of climate change.

The second section of the literature review examines risk communication. There is a large body of literature that examines risk communication, but this review focuses on best practices of environmental risk communication. How to best communicate these risks to adults will help to inform how to educate children about environmental risks.

The literature review continues with literature focused solely on children, their ideas about environment, environmental risk, and also of climate change. This subset of the literature is much smaller than the previous body of knowledge that focuses on adults.

The fourth section of literature focuses on how place might affect environmental ideas. Some researchers have examined how urban or rural environments help to shape residents’ attitudes towards the environment. Since climate change is an environmental issue, this body of knowledge might be useful to help to understand why, if at all, children’s ideas about climate change vary between urban, rural, and perhaps even suburban areas.

The last subset of literature examines methodological considerations for doing research with children. Methodologies for use with adults are not always best suited for children, as they have different levels of cognition and ways of communicating. There are issues of
confidentiality, risk, and sensitivity when working with children that are not always present in research with adults. Because of this, other and less traditional methods are sometimes used when working with children. Illustrations, as a method of understanding children’s thoughts, are sometimes used in qualitative research. This subset of the literature looks at some other studies that have used illustrations to collect research data with child subjects.

The intersection of children’s geographies, place, environmental education, and climate change knowledge provides a point of departure for this research. This chapter concludes with a brief summary of this literature and also with a visual description of the conceptual framework used in this thesis.

2.1 Adults’ Perceptions of Environment and Climate Change

2.1.1 Public Perceptions of Climate Change

Climate change is a problematic issue, in part, due to scientific uncertainty. While there is a general scientific consensus on many climate change issues, this consensus also recognizes that there is still uncertainty in climate model predictions. It is difficult to “know” the risks associated with climate change. In addition to this uncertain scientific consensus, the lay public is bombarded with information from a multitude of information sources, ranging from popular culture, media, governments, non-governmental organizations, and private businesses that are often inconsistent with the scientific consensus on climate change. This lack of clarity and consensus may be causing a lack of clarity amongst the lay public. Many of the differences are centered on the confusion of climate change issues with other environmental risks, or on carbon dioxide and its association with climate change.
Kempton’s (1991) early study of lay perceptions of climate change hypothesized that public conceptions of climate change tend to be shaped by previous knowledge and concepts, which include stratospheric ozone depletion, tropospheric air pollution, plant photosynthesis, and seasonal and geographic temperature variation. Later, Kempton (1997) described these four concepts as “cultural models” in which people tend to frame their knowledge of climate change. This term was used by Kempton to explain how pre-existing knowledge and ideas can influence a person’s understanding of a new or different phenomenon.

In the cultural model of photosynthesis and respiration, for example, climate change is a concern which can affect the carbon balance, through deforestation and increased respiration. This coincides with a perceived decreased availability of oxygen, which will threaten human life. This is not true, as CO₂ (by volume) is only a fraction (0.03%) of the earth’s atmosphere, whereas O₂ composes 21% - therefore a doubling, tripling, or even 8X CO₂ would not result in any major difference in atmospheric O₂ (Kempton 1997). In fact, CO₂ concentrations are much higher than atmospheric levels in many office buildings, within which there is more than enough oxygen to sustain life. The danger of this type of misconception is that public support may be swayed towards reducing deforestation and increased forest regeneration as a solution to climate change, as opposed to the reduction of fossil fuel consumption, which is a much more effective strategy and links directly to the root cause of anthropogenic climate change (Harvey 2000).

These cultural models, as proposed by Kempton (1997) have been found to be prevalent in other studies as well. Seacrest et al. (2000) suggest that the root cause of the misunderstanding of these cultural models – models which are much more familiar to the general public than climate change – is the confusion of the connection of CO₂ to climate change. Indeed, ozone depletion, an issue that has been highly publicized and linked with clear images
such as aerosol cans and sunburns, is confused with climate change by many individuals, including those with post-secondary degrees and scientists in environment-related fields (Mortsch, et al. 2000, McDanielset al. 1996). This is a major concern, especially since stratospheric ozone depletion (which causes a cooling effect in the stratosphere) and climate change (expected to result in an average warming) are largely unrelated. While synthetic chemicals such as Chlorofluorocarbons (CFCs) - the main contributors to the ozone hole - are GHGs, when compared to CO₂ they have relatively little impact on the anthropogenic greenhouse effect. For example, CO₂ is estimated to have a heating effect of 1.34 Wm⁻² (50% of the total due to GHGs), whereas CFCs are estimated to have a 0.23 Wm⁻² heating effect (Harvey 2000).

Kempton’s (1997) cultural model of tropospheric air pollution refers to an individual’s substitution of knowledge about visible “pollution” and its sources, for climate change knowledge. For example, visible air pollution from sources such as factories, cars, and even cigarettes (by some individuals, this is perceived as a source of pollution), is perceived to be the cause of climate change. Air pollution is, indeed, an important environmental issue. However, CO₂, the most important anthropogenic greenhouse gas is, in fact, colourless and invisible to the naked eye (Harvey 2000). This substitution of knowledge can create a misunderstanding of the causes (for example, some visible signs of air pollution include aerosols and other small particulate matter, which are not greenhouse gases) of climate change. Also, there is a risk that one might perceive a relatively “clean” environment (i.e. free from smog, smoke, or soot) as unaffected by climate change, because the signs are not visible.

The fourth cultural model of climate change, which Kempton (1991, 1997) describes is the cultural model of seasonal temperature variation. This does not refer to changes in the four
seasons from summer to fall and so forth, but rather to seasonal anomalies and irregular weather. Kempton (1991, 1997) found that participants tended to substitute knowledge of abnormal weather events or unseasonable changes in weather as indicators of climate change. For example, one might have remembered a very hot summer or heat wave and substituted that knowledge for an indication that the climate is changing. In fact, seasonal variability is normal to our general climatic patterns and can be due to a variety of causes including El Nino or volcanic activity (Harvey 2000).

The research described above suggests that the lay public’s perceptions of climate change and its connection to CO₂ and perception of long term changes in climate and seasonal weather anomalies is different than the scientific consensus. In particular, the lay public draws connections between “pollution”, other environmental issues, and climate change, potentially obscuring the direct impacts of CO₂ and its anthropogenic sources. This may confuse the public in terms of how they can reduce their impacts and contributions through energy efficiency in the home, when purchasing new products, or by choosing more efficient means of transportation (Plotnikoff et al. 2004). Furthermore, this confusion may contribute to a lack of willingness to address climate change at the individual level. Much of this literature on public perceptions of climate change is somewhat outdated. In recent years, with films such as the *Day After Tomorrow* and *An Inconvenient Truth*, and with more recent government initiatives to reduce energy consumption and highlight climate change as an important environmental issue, public perceptions, and the perceptions of children may have changed. This study seeks to assess if these same cultural models, as originally proposed by Kempton (1991) are still prevalent in children’s ideas of climate change and also seeks to make an academic contribution by updating the literature with a more recent study of children’s ideas and perceptions.
The existing literature suggests that climate change is an issue which has left the public confused, not polarized, in terms of what might happen and what should be done. There is much room for improvement in climate change communication, since most researchers suggest that effective environmental education, targeting, and clarifying the confusions among climate change and these cultural models can be integral to the mobilization of the lay communities to support for necessary climate change policies and actions. An increased understanding of what the common differences in perception are will help researchers understand the root causes of the miscommunication between the lay public and the scientific communities. This thesis seeks to help researchers identify any misunderstandings among children’s ideas of climate change, so that educators can help to bridge this gap between scientific communities, other organizations involved in climate change discourse, and the lay public.

In addition to these studies of what some of the common cultural models of climate change are, some researchers have also looked at risk perceptions of climate change, to understand the general public’s perception of the seriousness or severity of climate change. A few issues have caused a scattering of climate-risk discourses among the general public. These are the complexity of climate change and other environmental, financial, and political threats in our society and also the plurality of people’s priorities and perspectives (Etkin & Ho 2007). In addition to any confusion about the causes and effects of climate change, other world or personal issues often take priority (Lorenzoni & Pidgeon 2006). Smith (2005) suggests that much of the public’s polarization in climate change views is due to a mix of messages and narratives that are being presented by the media.

Sterman and Sweeney (2002) describe climate change risks among other environmental risks as being unique, because of its complex systems and interactions. That is, it is more than a
simple cause and effect mechanism (as opposed to the case of waste reduction, which leads to less space required in landfills), rather climate change systems are structured in ways that are not as easily understood. Sterman and Sweeney (2002) found that misunderstandings of climate change dynamics and projections were also prevalent amongst highly educated individuals. Their research surveyed graduate students at Harvard and the Massachusetts Institute of Technology (MIT), enrolled in Systems Dynamics and Business programs. The study concluded that even these “highly educated” individuals misunderstood rates of climate change (when compared to rates of change generally accepted by the scientific community), and the levels of GHG emissions reductions required to slow the current rates of climate change. The students tended to underestimate both the amount of GHG emissions required to effect any changes in the rates of climate change, and also the amount of time required for changes to occur. Sterman and Sweeney (2002) concluded that these misunderstandings are likely to exist elsewhere, amongst decision-makers and policy analysts, which would contribute to complacency and a “wait and see” attitude towards climate change mitigation. In addition, these attitudes are likely shared by the general public, further contributing to a lack of appropriate action by lay people.

Climate change is one of many risks that the public is asked to sort through, process, and prioritize. Each risk has one or more potential impacts and causes, and each person might perceive climate risks differently due to differences in worldview, psychosocial, or social-cultural factors (Leiserowitz 2006, Etkin & Ho 2007). The very fact that there is so much literature published on the public’s perceptions of climate change indicates the difficulty of defining exactly why the lay public tends to have views that do not always align with scientific consensus, and also why there is so much apathy, polarization, and confusion. The public’s understanding of climate change, however, is integral to successful adaptation and possible
mitigation. Without understanding the causes of climate change, actions that the public might undertake to mitigate might be less effective. For example, the cultural model of ozone depletion, applied to the issue of climate change, can result in public action to reduce the use of CFCs, which is in fact, not the most effective course of action. This can then take resources and efforts away from more useful actions. The potential confusion of useful adaption strategies and mitigation options are perhaps even more important to clarify than any existing scientific certainty and more important than creating new or enforcing existing governmental policies (McDaniels et al. 1996).

These cultural models of climate change and the literature regarding how adults understand climate change are used in this thesis as a point of comparison to children’s ideas, in order to assess if children view climate change in the same way as adults. In addition, how these environmental issues and risks are communicated is important to climate change education. The following section examines climate change risk communication.

2.2 Climate Change Risk Communication

Risk communication has been widely studied and its successes and failures have been observed in a wide range of examples including Mad Cow disease, drinking and driving, and silicone breast implants (Leiss & Powell 2004). However, it is a relatively new discipline of study. Fischoff (1995) describes how risk communication as a field of study has emerged due to the recognition that earlier models of risk communication have often been flawed and ineffective. Assumptions of “right” and “wrong” as well as assumptions of who “owns” information and who ought to “receive” have permeated traditional methods of communicating risk “to” the public. This calls for a change from expert-led risk decision-making to a process of
understanding risks and making decisions about those risks that involve other parties, stakeholders, and of course the public. By involving other parties, effective risk communication is able to become a dialogue, of which an important step is listening to the ideas and concerns of all interested groups.

How risk is communicated is a very complex issue, and in general, is related to how the risk information is transferred and also the ethical imperatives of the risk decisions made by risk assessors, risk managers, members of the public, regulatory practitioners, and interest groups (Grima 1999). Fischoff (1997) describes common causes for poor or ineffective risk communication between these groups, which include disagreements over principles or approaches to risk assessment, different base information that is available to different parties, arguments over contested data and validity, or the communication of misinformation. In these cases, when some or all of these issues arise, Fischoff (1997) describes the creation of a risk communication “vacuum”, which is a void between the public as a whole, and the scientific risk assessors. When this vacuum occurs, there is often opportunity for media bias, sensationalism, selective use of information by a wide range of parties involved, or other opportunities to further skew the effective transfer of risk information.

Frewer (2004) details the important role of the public in risk communication, which is similar to Fischhoff’s (2004) model that includes the public as an important stakeholder in risk communication activities. Frewer (2004) states that public perceptions of specific hazards are integral to effectively communication risk. Institutions, regulators, government, and scientists need to learn how to understand public perceptions of hazards, internalize those ideas and values (judgments of what is and what is not important) and integrate those messages in practices of risk communication. In doing so, a best practice of risk communication would take into account the
public’s (or indeed any “recipient” of a risk message) concerns and ideas, as well as the messages that need to be communicated and in the case of this study, the issues that need to be addressed in climate change education.

Heath (2006) summarizes some best practices of crisis communication. “Crisis”, as he defines it, is “risk manifested”, for example the spilling of the Exxon Valdez is the manifestation of the risk of transporting large amounts of oil through Arctic waters. While climate change may be debated as a risk or a risk manifested, many of the best practices summarized by Heath (2006) are of interest. These include:

- Partnerships with the public – recognizing the value of dialogue and fostering mutually beneficial relationships;
- Listening to others’ concerns – demonstration of respect, concern, commitment, and shared interest between organizations and the public;
- Collaboration and coordination with credible sources; and

These best practices highlight the importance of the relationship between the public and organizations that wish to communicate climate change. They also recognize the role of uncertainty in climate change communication, and that such uncertainty must be communicated and disclosed, rather than hidden. These best practices move traditional risk communication practices beyond a simple one way transmission of messages from organizations to the public and expand this communication to include active listening to the public’s concerns, ideas, and priorities. This thesis attempts to do this by understanding children’s ideas about climate change.

The media’s role in climate change communication has been extensively studied and reported in the academic literature. McComas and Shanahan (1999) describe a cyclical nature to
the narratives of global warming in the media, which follows a pattern of emphasis on disaster and extreme events, followed by scientific uncertainty, and finally emphasis on the economic costs of trying to mitigate climate change. This narrative cycle tends to repeat itself and McComans and Shanahan (1999) suggest that the end result might discourage future attention to global warming. However, more recent publications suggest that climate change remains an important issue in the popular imagination, and has attracted much media attention since McComas and Shanahan’s (1999) publication. Smith (2005) describes a plethora of climate change-related stories in media reports, and that climate change has woven itself into news that covers economic, agricultural, educational, political, security, energy and transportation stories. Smith (2005) suggests that the media are part of a “tangled web” of climate change risk communicators, and their specific role in public understandings of climate change are difficult to discern due to this complexity but nonetheless, is integral to understanding how climate change risks are communicated. The media, in this web of climate change risk communication, often presents sensationalized, unbalanced, and inappropriately-scaled reports of climate change that further distort effective risk communication. This is important to this study as the media might be a source of climate change information in students. Climate change is not currently part of the elementary science curriculum, and so students in this study might refer to information gained from popular media sources.

Meijnders et al. (2001) describe the fundamentals of effective risk communication within the context of climate change. First, the goals of this communication are both to clarify the relationship between climate change and fossil fuel consumption (a common public misconception as identified by Kempton (1997)) and to promote energy conservation as an strategy to mitigate climate change. Meijnders et al. (2001) stress the importance of personal
relevance in climate change risk communication, so that individuals can internalize the issues and process the information in more than just a superficial manner. In addition, the communication of these risks can be made more personally relevant if appeals to fear are presented in the information. However, this can also be a problem, as increased fear can lead to a perceived lack of control and hence inaction (Meijnders et al. 2001) and so these fears need to be combated with explanations of the risks and suggestions for practical and achievable individual actions to mitigate climate change.

However, this effective risk communication is often influenced by factors such as the risk communication “vacuum” described by Fischhoff (1997), narrative cycles described by McComans and Shanahan (1999) and the tangled role of the media, described by Smith (2005). Clearly, the task of effective climate change risk communication is clouded by many factors. This thesis seeks to understand how climate change risks have been communicated to children, as in addition to many of the same communications channels as adults, they are also exposed to more formal schooling on a day-to-day basis. The following sections examine how children understand environmental issues and climate change.

2.3 Children’s Perceptions

2.3.1 Children and the Environment

This section of the literature review attempts to justify why children and the environment are worthy of scholarly research. Children, as a group, have been somewhat marginalized in geographic study (Matthews & Limb 1999). As opposed to being objects of study, there is a need for children’s views and perspectives to be studied (Chawla 2002a). Stefanovic’s (2004) study of
children and place indicates how children’s perspectives of nature and environment are different than adults and calls for the integration and recognition of children’s views in environmental study and discourse. Children’s connection to the environment and sensitivity towards environmental issues tends to be greater than that in adults (Chawla 1988). Matthews and Limb (1999) present seven major distinctions between children and adults that ought to be considered in geographic research:

- Children’s ‘ways of seeing’ differ from those of adults;
- Children’s place use differs from that of adults;
- Children’s free-range differs from that of adults;
- Children’s environmental fears and sense of danger differ from those of adults;
- Children’s place feelings differ from those of adults;
- Children’s relationship to environmental decision-making differs from that of adults; and,
- Children’s democratic responsibility differs from that of adults.

Each of these distinctions is important to the study of child-adult-environment relationships as they outline differences in perceptions, roles, and power. All of these distinctions are potential sources of differences between children and adults and their perceptions of climate change risks.

In addition to these different geographical perspectives, some literature suggests that children have unique relationships with nature (Chawla 2002b). Children are more likely than adults to have an “enthusiastic” approach to learning about and interacting with the environment (Batterham et al. 1996). The emotional, ethical, and developmental differences in children cause unique situations through which children have opportunities to bond with and interpret nature. This bond or connection is often “lost” by the time children reach adulthood (Kahn 2002). However, children’s exposure to nature and other experiences that promote an appreciation for
the natural environment can have a very positive impact on their adult environmental perspectives (Kellert 2002). This experience with nature is integral to how children perceive of and care for the environment, and has been shown to be more effective in fostering pro-environmental behavior in children than in-class educational techniques alone (Bogner & Wiseman 2002). This finding is relevant to this thesis because it suggests that children in rural environments, who are likely to have more direct contact with the natural environment than children in urban environments, might have different views about the environment that children living in other areas. If children in different environments have different environmental views, then they might also have different ideas about climate change. Their varied lived-environments and exposure to natural settings might affect how they view these environmental issues.

Kahn and Friedman (1995) and Howe et al. (1996) suggest that children’s perceptions of environment are largely anthropocentric, where harm to the environment is perceived as being morally wrong, as that harm impedes the use of the environment for human purposes. They suggest that even with this human-centered perspective of nature, there is also an intrinsic care for the environment evident in children’s perceptions and children are naturally sensitive to environmental issues and problems. This is likely due to the fact that the intrinsic care for the environment stems from a care for one’s own environment and how that environment affects individuals. Kahn and Friedman (1995) and Howe et al. (1996) drew these conclusions studies of children’s perceptions of environmental pollution and littering, and not specifically of climate change. These anthropocentric perspectives, along with care for the environment, suggest that these children tend to exhibit hierarchical and egalitarian perspectives of the environment. Distinguishing between the two would depend on the children’s perceived severity of human actions and their potential impact on the environment.
Environmental education is highly important to the development of children’s environmental ethics and values. How concepts are taught and when material is presented are both influential. Children are exposed to environmental content in schools from pre-school onwards, from lessons in stewardship (i.e. “no littering”) through to more complex teachings on the causes, effects, and moral implications of current environmental issues. The timing of environmental education is important, as early misconceptions and misinformation can be difficult to correct later in adolescence and adulthood (Palmer 1995, Batterham et al. 1996). How children take in and process environmental information is highly dependent upon their pre-existing ideas about how the world operates and how they perceive risks (Batterham et al. 1996). These pre-existing ideas (e.g. that nuclear power is bad, or that the hole in the ozone layer is allowing more sun to reach the earth’s surface, causing global warming) are somewhat resistant to change; however, formal education has been shown to be a more effective way of educating children about hazards and environmental risks than at-home instruction (Ronan, et al. 2001) due to its regularity and structure.

2.3.2 Children’s Perceptions of Environmental Risks

Much of the research on children and environment has focused on children’s views of the natural environment. Much of this literature suggests that children tend to have optimistic and caring attitudes towards the environment, as adults tend to be as well (Joffe 1999). Children also tend to be sensitive to and aware of the potential dangers of the environment (Kahn & Friedman, 1995; Batterham et al, 1996; Kellert 2002). Perceptions have been found to vary due to factors such as age, gender, and (Bjerke et al. 1998). Children can sometimes describe environmental
risks with fright and severity (Brown & Armstrong 1995). Still, the literature does point towards optimism and a perception of low risk to self among children (Whalen et al. 1994, Howe 1996). Children’s optimism is directed towards themselves, rather than towards their peers or other adults (Albery & Messer 2005). This means that children tend to overestimate positive benefits for themselves and also overestimate the negative outcomes for others. For example, children interviewed in Whalen, et al. (1994) tended to view their own risks related to toxic waste exposure as being lower and less severe that their peers’ risks related to the same environmental hazard. This positivity and optimism can be apparent even when risky situations present themselves at children’s doorsteps. Dodman (2004) describes how children in Kingston, Jamaica are aware of health, safety, and environmental risks in their area but are still highly optimistic about their own well-being and even more so, are optimistic about their roles in re-shaping the future of their surroundings. Joffe (1999) also describes self-optimism in risk assessments in adults. “Others” tend to be more susceptible to risks than one’s self, which can affect risk taking behaviours, and risk assessments. Popay (2003) also describe optimism in self-assessments of health risks, even for those individuals living in less advantageous areas than their neighbours. Therefore, self-optimism seems to be prevalent in both children and adults. Of course, this optimism can vary from case to case. Location, experience, and culture can all affect children’s environmental risk perceptions. Children in developing regions or children who have experienced environmental risks first hand may be more likely to have more accurate estimates of risks to self (Khan & Friedman 1995, Howe et al. 1996, Dodman 2004). Yet there still seems to be a perpetual theme of positivity and optimism in their perspectives.

The research on children’s risk perceptions have focused on how children perceive risks, and more specifically, what those risks seem to be and how they portray them. The children in
this study might have different lived experiences, due to their exposure in rural, urban, and suburban environments (which are explored in more detail later in this chapter). These areas might provide a different cultural context, through which the children tend to learn about and rationalize their environmental risks and risks of climate change. As a whole group, children’s views are shaped by their formal education (and in the case of this study, children in all three regions are subjected to the same educational curriculum), and other cultural factors that are different than adults and even each other. These could include their home lives, influences of the media, and other social influences.

In summary, children ought to be considered as important actors in academic study, regardless of their future development into adults. Second, their development into adults is still important, so that we might be best able to encourage the growth of young adults that are environmentally conscious and stewards of the environment. Third, if we are to educate children to have environmentally positive ethics, then part of this education needs to happen formally, in the classroom. Certainly not all children can be grouped together in a homogenous way. This thesis seeks to see if these views are present in children’s ideas about climate change, to see if groups of children from different geographic areas have similar ideas of climate and more broadly, to see if there is relative optimism in children’s perceived risks.

2.3.3 Children’s Perceptions of Climate Change

Some researchers have begun to examine how children perceive and understand climate change and the greenhouse effect. Unlike general environmental perceptions or environmental hazards, climate change might be a unique area of understanding because of its difference in physical presence. Many of the environmental perception studies ask children to recount and
discuss their ideas about a physical place or lived experience (Stefanovic 2004, Panelli & Robertson 2006). Children tend to be less knowledgeable about places that they have not encountered through direct lived experiences and are less knowledgeable about places that are far away (Palmer 1993). It can be argued that there is less of a direct and tangible lived experience associated with climate change than with many other environmental issues or ideas.

Much like the literature on adult perceptions of climate change, research on children’s perceptions has found that there are certain conceptions and beliefs that many children tend to hold that differ in important ways from the emerging scientific consensus on climate change. Ozone depletion is often misunderstood as a cause of climate change by adults (Kempton 1991, Kempton 1997, Plotnikoff et al. 2004). The literature also indicates that children hold this same misconception. In fact, over 50% of children (of varying ages) confuse ozone layer depletion with climate change (Rye 1997). Andersson and Wallin (2000) report that children (aged 5-12) tend to list “geophysical effects” of ozone layer depletion as the third most important effect of climate change, following harmful burns and increased rates of cancer. These geophysical effects are most often increased temperatures. For example, when asked what the effects of ozone depletion are, one student answered “it can make it so that the sun comes and makes it get too warm on earth and many inhabitants can get cancer” (Andersson & Wallin 2000: 1106). The differences between ultraviolet radiation (non-heat causing) and infrared (heat-causing) radiation is unclear to children and this is the root of their confusion of climate change with issues of the ozone layer (Koulaidis & Christidou 1999). Protection of the ozone layer, as well as reduction of the use of aerosol cans (with CFCs), are some of the ideas that some children have about how to effectively reduce global warming (Daniel et al. 2004). Ozone layer remediation and the effects of depleted ozone have been popularized by schools and the media to the extent that its
significance has permeated other atmospheric and environmental issues. The problem with this is twofold. First of all, confusion with ozone layer depletion means that children (and adults, as mentioned earlier) do not understand the fundamental science behind climate change and greenhouse gases. The difference between solar, infrared, and ultraviolet radiation is not made clear, nor are the mechanisms behind issues such as increased carbon dioxide, decreased stratospheric ozone, increased tropospheric ozone, or CFCs. Secondly, this causes children to believe that remediation of ozone layer depletion (i.e. ceasing the use of aerosol spray cans) is an effective way to mitigate other atmospheric or environmental issues, such as climate change.

Other issues that children tend to confuse with the issue of climate change include: recycling, waste production, deforestation, nuclear power, and endangered species (Lesson et al. 1997, Andersson & Wallin 2000, Boyes & Stanisstreet 2001, Daniel et al. 2004). While some of these issues are related to climate change, they are often confused in some way. For example, deforestation is a major cause of global warming, as it causes stored carbon in the vegetation to be released back into the atmosphere as carbon dioxide and is a removal of a carbon sink (Harvey 2000). However, it can be perceived as related to climate change purely because it is a negative or wrong thing to do. The underlying science of why deforestation is related to climate change is unclear to children (Daniel et al. 2004). Also, Daniel et al. (2004) found that children tend to view nuclear power as a cause of climate change. In fact, while nuclear power does have its own environmental risks and impacts, it can be considered to be an alternative energy source that does not contribute to climate change through greenhouse gas emissions (Lesson et al. 1997, Harvey 2000).

What is clear from the literature is that there are so many environmental issues that children are taught in schools, or exposed to in the media, that these other issues and ideas are
permeating the discourse around climate change. Furthermore, when children are unsure of issues such as climate change, other environmental knowledge (such as endangered species) is used to explain or clarify the information gap. Several researchers have suggested ways in which these can be clarified in schools, by teaching to the specific misconceptions or scientific causes and effects (Palmer 1993, Andersson & Wallin 2000). Some researchers have indicated that classroom instruction can have positive impacts of reducing some of these misconceptions by teaching directly to specific issues such as the difference between ultraviolet and infrared radiation, and the mechanics of the greenhouse effect (Rye 1997, Boyes & Stanisstreet 2001). This study seeks to understand if these misconceptions are still prevalent among school children, or if more recent media and educational attention on these issues have clarified these concepts.

In summary, children’s ideas about climate change (as found in the literature) are somewhat similar to the cultural models presented by Kempton (1991). Where adults tend to use ozone depletion, deforestation, seasonal and geographic variation, and pollution to understand climate change, children (from the literature presented above) do not tend to use seasonal variation to describe climate change, but also use ideas of recycling, nuclear power, and endangered species to describe climate change. This thesis aims to assess if these differences still exist (as some of the literature is somewhat outdated) among children in Ontario, Canada, and if any differences occur between urban, rural, and suburban children.

2.4 Place and Perceptions

This study also seeks to understand if place affects children’s ideas about climate change. There has been much research on how place can affect ideas about nature or perceptions of wilderness. In this thesis, “place” refers to either an urban, or a rural setting, where it is assumed
that people in urban settings will be connected in a different way with the natural environment than residents in rural settings (Lutz et al. 1999). This is not to say that urban residents are less concerned with the natural environment than rural residents (Bogner & Wiseman 1997, Williams & Cary 2002), but that their relationships with nature and perceptions of environment are different. Tuan (1990) explores the impacts of the built environment and of city vistas on urban ideas of idyllic landscapes. One’s immediate surroundings, that one has lived in since childhood, can influence perceptions of nature and values. Tuan (1990) goes on to discuss the suburbs as a medium between rural and urban values; as areas that hold the middle ground between these two polarities.

These landscapes affect how its residents understand their worlds. For example, what is considered “wilderness” or “untamed” to an urbanite is often vastly different to that of a rural resident (Lutz et al. 1999). Conversely, what some urbanites view as environmental protection, other rural residents might view as economic impediments (Switzer 2001). This is contrary to other researchers that have indicated no real difference between urban and rural environmental values (Bogner & Wiseman 1997, Williams & Cary 2002, Kaplowitz & Kerr 2003). These studies indicate that contrary to previous studies, the rural-urban differences in environmental values are diminishing. Still, some researchers do indicate an urban/suburban difference in school children’s environmental attitudes (Yilmaz et al. 2004) though these differences might be more due to differences in socio-economic status. Taskin (2006) has criticized the work by Yilmaz et al. (2004) due to poor definitions of urban and suburban schools and also due to unclear data analyses.

There is some debate as to whether or not there are urban and rural differences in environmental perception. Furthermore, the suburban landscape, one that is influenced by both
rural and urban spheres (Tuan 1990) with sometimes very affluent and educated residents (Gordon & Tamminga 2002) or conversely lower-income and less educated inhabitants (Yilmaz et al. 2004) is a “middle ground” between urban and rural areas. The suburbs are places that have different modes of transportation, built landscape, and daily activities from both urban and rural areas.

These three areas are of interest to this thesis because they each provide different environments, which children are growing up in, and through which children might be learning about the environment and their roles in nature. This study seeks to understand if place affects children’s ideas about climate change, by working with children from suburban, urban, and rural settings. Furthermore, this study seeks to understand if these places have created different cultural contexts, which might shape children’s ideas of climate change. These urban, rural, and suburban differences might be one component of the societal processes that shape environmental perspectives.

2.5 Methodological Considerations

One of the research questions for this thesis seeks to assess if alternative qualitative methods can reveal new or different information in studies with children. In particular, this thesis is interested in illustrations as a complementary research method to open-ended interviews. This portion of the literature review explores these methodological considerations.

2.5.1 Questionnaires and Interviews with Children in Climate Change Studies

Much of the research on children’s attitudes towards or ideas about climate change has been conducted by Edward Boyes and Martin Stanistreet (Boyes et al. 1993, Boyes &
Stanisstreet 2001, Daniel et al. 2004). Their most recent publication (Daniel et al. 2004) used a questionnaire to assess students’ perceptions of climate change and global warming (students aged 11-16). The questionnaire asked participants to judge the effects of certain actions and whether or not that action would “help to stop global warming”. For example, one question was “If we protected the ozone layer, would this help to stop global warming?”. Children were asked to respond with either, “a lot; quite a bit; a little bit; or not at all”. This research indicated how these participants ranked these actions and their impact on reducing global warming. The questions presented in Daniel et al.’s (2004) questionnaire were quite structured and guided, giving respondents a specific set of actions to rate. This also implies that a student with little familiarity with the subject matter could still complete to questionnaire and perhaps still answer some questions correctly. This is important to consider in research with children, as closed-form questionnaires might sometimes produce results that are not truly representative of their knowledge.

Other researchers have chosen to use more open ended interviews as a research method. Rye (1997: 534) describes the results of interviews with students, aged 10-13, following an instructional school unit on global warming. The interview asked a few open ended questions, based on just a few basic questions related to the nature and cause of global warming, connections between global warming and ozone, actions to resolve global warming, and why this is an important issue. The study found that even after formal instruction on global warming, approximately half of the students sampled still confused ozone depletion as a major cause of global warming. There is obviously a deep rooted connection to other environmental issues in these students, causing them to hold onto misconceptions about ozone depletion, even following formal instruction. Adults also misconnect ozone depletion with issues of climate change
(Kempton 1997). If this cultural model of ozone depletion continues to permeate children’s and adults’ perceptions of climate change, then efforts to mitigate climate change might be misdirected towards efforts to reduce ozone depletion.

Rye’s (1997) use of open ended interviews allowed for more elaboration and conversation between researcher and research participant. As a research method, this is extremely useful in gaining an understanding of how participants perceive a particular topic, without giving them a set list of responses to choose from (as it would be in the case is a more closed-form questionnaire). However, there is always a risk of influencing the research participant, through the phrasing of the question and through the verbal and non-verbal responses given by the researcher (Flowerdew & Martin 2005).

Andersson and Wallin (2000) used written open ended questions to elicit responses from students aged 15-16 and 18-19 regarding their perceptions of the greenhouse effect, carbon dioxide emissions, and ozone layer depletion. The study found that students were relatively well informed about the dangers of ozone layer depletion to human health (through increased ultraviolet radiation) but relatively less informed about the greenhouse effect and the societal implications of reducing carbon dioxide emissions. Open ended written responses are more likely useful for students in these older age groups as their levels of written communication are more developed than young children, as is their ability to stay on task and complete a written test with little or no clarification from a teacher or researcher. This third method of using written responses can be thought of as a middle ground between a personal interview and a closed form questionnaire, each with its own opportunities and disadvantages. A fourth, and alternative method (since it not used as often in studies with children or in studies of environmental
perceptions), using illustrations as a method of eliciting children’s ideas about climate change, is presented next.

2.5.2 Illustrations as a Method in Qualitative Research

The focus for this section is the use of children’s illustrations as a method for understanding attitudes and experiences in qualitative research of climate change. Researchers have particularly noted the importance of diagrams and illustrations in research with children. Various methods can be used when conducting research with children, depending on the subject matter and the age of the participant. Visual techniques can be very effective for children that are old enough (often older than six years of age) to understand the spatial relationships on paper, in the form of maps (Matthews 1985). Illustrations, as a method of data collection, are used throughout social sciences in participatory methods and also in situations where oral or written communication between subject and researcher might cause difficulty or tensions (Flowerdew & Martin 2005). Geographers, among other researchers such as environmental psychologists, have used mapping and diagramming techniques to collect “mental maps” from research subjects, most often from children, from subjects that speak a different language than the researcher, or from subjects that are not comfortable with written communication (and might have difficulty with a written survey or questionnaire) (Flowerdew & Martin 2005). For example, one might ask a research subject to map out his or her neighbourhood, in order to understand places of significance. Geographers also use mental images of places to understand how people interact with and perceive places and spaces (Gould & White 1992). When research participants illustrate these mental images, researchers can attempt to construct themes by coding objects and images, or by understanding how items are visually depicted. The importance of the
image is that it is a visual description of ideas and significance, one that can be lost in more traditional methods of data collection.

Brown et al. (1995) used illustrations of nuclear power stations to understand children’s perceptions of environmental risk. Drawings were coded according to the presence of particular features or attributes to gain an understanding of what aspects of nuclear power stations were perceived as risky or dangerous. This method can allow researchers to take advantage of large or small samples sizes and conduct a standardized format of analysis by simply counting image or object frequencies.

Panelli and Robertson (2006) used children’s images of a river environment to understand how these research participants perceived a specific area. The data were coded by content (for example, illustrations that included images of people swimming or trees and vegetation) and were analyzed by gender, age, and location. The study argued that these children ought to be seriously considered in environmental planning and restoration and that their perceptions of these areas were diverse and complex.

Alerby (2000) used children’s illustrations of the environment to understand nuances and diversity in children’s thoughts and attitudes. This was done by classifying images into themes related to “the good world, the bad world, the dialectics between the good world and the bad world, and symbols and actions protecting the environment” (Alerby 2000: 211), which emerged from the data through grounded theory.

Stefanovic (2004) also argued for the importance of children’s illustrations and the breadth of knowledge that they can offer. In this study, illustrations were used to elicit children’s ideals
and thoughts about special places. The illustrations were thought of as a window into the children’s world, through which the researcher can examine.

There is much research to support the use of illustrations in academic research, especially when concerned with children’s thoughts and ideas. This is mainly because such drawings give researchers opportunities to have a glimpse into the mind’s eye of the research participant. However, these illustrated methods have not been applied to studies of the perceptions of climate change. In fact, most researchers of perceptions of climate change focus on adults (Kempton 1997, Seacrest et al. 2000, Leiserowitz 2004). Few studies have taken on children’s perceptions of climate change, except those that have use structured questionnaires (Boyces & Stannistreet 2001; Stannistreet & Boyes 2004), written assignments (Andersson and Wallin 2000), or interview techniques (Rye 1997, Koulaidis & Christidou 1999). Illustrated methods might also be useful to illicit children’s ideas about climate change and other environmental issues. While climate change might be a difficult concept to “visualize”, it certainly might evoke certain imagery or ideas. This thesis seeks to understand what ideas children reveal about climate change, in a more open-ended research environment, through the use of both semi-structured interviews and illustrations. It also seeks to assess if the information gained from the illustrations is complementary to the open-ended interviews, and also to see if they contribute new themes and data to the study.

2.5.3 Grounded Theory as a Research Approach

Once data are gathered, a suitable approach must be taken to draw out meanings and conclusions from the interviews and illustrations. Qualitative approaches are used to seek out personal experiences and ideas, and to allow for some subjective analysis from the researcher.
These approaches do allow for relevant and valid conclusions, though they ought not to be measured by the same rules of generalisability and reliability (Mays & Pope 2000: 51). There are still criteria for “best practice” qualitative research, which can alert researchers to scrutinize research design and outcomes. In the case of this thesis, self-reflection and a continuous revisiting of the data and study results allowed for revisions of the research process and the outcomes. This involves a continuous examination of assumptions, methodology and analysis.

This thesis seeks to explore children’s ideas about climate change from these research methods, with minimal influence from pre-existing ideas or theories. Grounded theory is an approach to research that allows themes and theories to emerge from the data, rather than from hypothesis or other research (Donalek 2004; Flowerdew & Martin 2005). It is contrasted with deductive quantitative approaches, which seek to test and validate pre-existing theories. Instead, it allows for theories to develop from the data themselves. It involves reading and re-reading the data to sort them into groups and common themes. These themes and groups can change over time, either with more frequent readings or as new data are collected (Charmaz 2006). These themes are coded, that is, as researchers analyze their data, they flag phrases or ideas in the text as being part of a particular theme or idea. The codes themselves allow for data retention, rather than reduction (Richards 2005). These qualitative codes that emerge through the use of grounded theory allow the researcher to ask new questions about the data, search for combinations and relationships of categories, and also to find patterns that might exist (Richards 2005).

Grounded theory and its use of codes are also useful because it allows for a quantifiable method of communicating results. The number of occurrences for each code can be counted and also compared among research groups or subjects. It has linkages to positivist and quantitative
approaches, as the groups of themes and codes can be quantified and compared with the use of descriptive statistics (Charmaz 2006). It can serve as a bridge between the open-ended and subjective nature of qualitative approaches, and more easily comparable quantitative approaches. Because of its linkages to quantification, it has been sometimes referred to as “post-positivistic”. Although a qualitative approach, it has moved beyond this as it acknowledges that there is no “one truth” that the researcher pulls from the data, but rather than the approach is used to allow the researcher to reveal one version of the truth, which might be different to different people (Corbin & Holt 2005:50).

There are other different types qualitative approaches, some of which include ethnography and phenomenology. Donalek (2004: 422) describes some of these and their relative utilities. Ethnographic studies are also concerned with the culture and behaviour of a particular group or groups, and normally involve in-depth relations with the research subjects and even dwelling with the subjects for a prolonged period of time. Since this study assumes that there might be a similar culture among different groups of children and is more exploratory in nature, an ethnographic study is not the best practice. Phenomenological approaches aim to understand a person’s lived experience. Since climate change might not be a conscious “lived experience” for these children, this approach was not used. Instead, this thesis draws from grounded theory to analyze interview data and illustrations, to allow the themes and ideas to emerge from the data. Also, it provides a framework for comparing these themes and ideas to the findings from other researchers. It also allows for between group comparisons for the urban, rural, and suburban data sets to see what differences (if any) exist.

2.6 Summary of the Literature
The literature presented here indicates some important points that will help to guide this research project. First of all, research on adult perceptions of climate change indicates that there are many misconceptions about the causes and effects of anthropogenic climate change. This can affect how we choose to adapt to and mitigate this environmental problem. There are also many other factors that influence how adults understand and prioritize climate risks, including scientific debate and uncertainty (Etkin & Ho 2007). The popularization of climate change and global warming by films such as “The Day After Tomorrow” have added to this confusion by sensationalizing and exaggerating the science behind climate change (Leiserowitz 2004). Other films, such as “An Inconvenient Truth” have taken a more serious approach, and as time progresses, the issues of climate change are coming to the forefront of popular environmental discourse.

Effective climate change risk communication will have to compete with mixed messages and sort through a complicated “web” of climate change communication (Smith 2005). In order to be effective, Meijindres (2001) suggests that link between carbon dioxide and climate change be made more explicit by risk assessors and scientists, to clarify uncertainty amongst public perceptions. Fischoff (1997) suggests that in addition to clarification, effective risk communication must be influenced by both the scientific community and the lay public, for a discourse that is more than uni-directional. In order to do this, a better understanding of the public’s (and in the case of this thesis, of children’s) perceptions is required.

Relatively few studies have examined children’s ideas about climate change. Those that have done so reveal some common misconceptions with adults, most notably related to the cultural model of ozone depletion (Boyes & Stanisstreet 2001). Children tend to be more
optimistic about the risks of climate change to themselves than they are to the risks of climate change to others (Whalen, et al. 1994).

This study needs to consider the methodological opportunities and challenges of working with children. Often, open ended interviews and grounded theory are used when research is exploratory in nature (Corbin & Holt 2005; Flowerdew & Martin 2005; Charmaz 2006). Closed form questionnaires are best used for larger samples and when a range of possible responses are already known. Some researchers have used such techniques to assess children’s environmental and climate perceptions (Khan & Friedman 1995, Bjerke et al. 1998, Boyes & Stanisstreet 2001) while others purport that more open ended and qualitative techniques are more suited to children, especially younger children (Matthews 1985, Chawla 1988, Palmer 1993, Matthews & Limb 1999, Stefanovic 2004).

Some researchers also suggest the use of illustrations as a method of drawing out ideas and themes from children (Brown & Armstrong 1995, Alerby 2000, Stefanovic 2004). Children can sometimes withdraw when asked to be interviewed one-on-one by an unfamiliar adult, and so alternative methods of data collection, such as the use of illustrated responses, can provide children with a “safe” way of communicating their ideas. In addition, such methods can reduce researcher influence and bias, as children often look to the interviewer for approval or indication of a “correct” response (Matthews 1985). This thesis seeks to contribute to the body of literature on children’s ideas about climate change through the use of open-ended research methods of interviews and illustrations.

Place might have a significant influence on how adults and children perceive climate change and climate risks. Researchers have shown that urban and rural residents can have
different views of nature and wilderness (Lutz et al. 1999). However some researchers have found that place can affect how individuals perceive environmental issues and their importance (Switzer 2001, Yilmaz et al. 2004), while others conclude that place does not affect individual environmental risk perception and valuation (Bogner & Wiseman 1997, Williams & Cary 2002, Kaplowitz & Kerr 2003). This study seeks to determine if any differences exist among urban, rural, and suburban children in relation to their ideas about climate change. Climate change is, perhaps, less "tangible" than other environmental issues or ideas such as wilderness preservation or littering. This study seeks to understand if the built environment and physical surroundings might influence how children think about climate change. There is a large gap in the place-based environmental perception literature with regards to climate change in adults as well as children, and this thesis seeks to fill in these gaps by determining if such differences exist.
3. Methodology

3.1 Overview of Methodology

This chapter details the methodology used in this thesis. As mentioned previously, the main research questions being addressed in this thesis are:

1. How do children, aged 11-12, perceive climate change and climate-related risks?
2. Do any differences exist among students in rural, urban, and suburban areas of Ontario, Canada?
3. How do these perceptions and ideas differ from those of adults, as found in the literature?
4. Do these perceptions, similarities, and differences signal a need for a new educational framework for climate change education and if so, what might that framework consist of?
5. What are the merits of qualitative research methodologies, in understanding children’s ideas about climate change? Do less traditional methods, such as illustrations, make a new contribution to research methods with children?

Two techniques for data collection were used in this study in order to better understand children’s ideas about climate change and climate-related risks. Children in urban, rural, and suburban areas were asked to provide illustrations of climate change and were also asked to participate in one-on-one, open-ended interviews. These two techniques were used to answer the first two research questions, and the data from the literature on adult perceptions were used to compare to these findings in order to answer the third research question. Figure 1 summarizes the overview of this methodology and also how this methodology relates to the main research questions.
3.1.1 Research Bias, Judgments and Autobiography

My background, as a trained teacher and as an advocate for environmental education, has influenced the shaping of the research questions. These questions arose from my observation of
children’s environmental education and knowledge of climate change that I have observed in my school aged students, as well as in students I have taught at the post-secondary level. In my years of teaching experience, and in teaching students in a wide range of geographical settings in Ontario, I have observed that some students are very knowledgeable about climate change, while others, and even at the post-secondary level, tend to have opinions of climate change that are markedly different from the scientific consensus on climate change. Also, my knowledge of the Ontario Curriculum has prompted me to undertake this research. The Ontario Curriculum is often critiqued by educators as being too wide in breadth, and provides little opportunity for in-depth analysis at the elementary and post-secondary levels. I sought to investigate children’s ideas about climate change in reaction to these experiences, to examine in a more rigorous way, children’s perceptions of climate change and also if place has an effect on these perceptions.

My experience as a teacher in suburban, urban, and rural areas of Ontario lead me to believe that children in these different areas have different connections with the environment and environmental thinking. Also, as a child that grew up in suburban Toronto, I observed in my own life, the ways that my peers interacted with the environment in a very disconnected way. Our reliance on automobiles and transit, our tendency to recreate in built areas and often times a “fear” or more naturalized places suggested to me that place does have an effect on a child’s environmental connection and understanding. These experiences prompted me to investigate not just how children understand climate change, but also if these understandings are affected by their urban, rural, or suburban settings.

Finally, my own perspective as a student of climate change and as an “environmentalist” or someone who values the natural environment and views many human influences on the environment as negative prompted has influenced this research design. I recognize that these
views could influence my interpretation of the information presented. I did, however, attempt to minimize bias and reduce the influence of personal values on the research results. Notions of the “rightness” or “correctness” of ideas of climate change have been derived from the consensus in the scientific literature on the causes and effects of climate change. Minimal feedback was given to students during interviews and during the drawing of illustrations in order to minimize the possibility for my own values or ideas to impact on the students. The use of grounded theory is explored in the literature review as well as the analysis of the data. This research approach allows for one version of the “truth” to emerge from the data, acknowledging that other researchers might find different versions of the “truth” from the same data sets (Corbin & Holt 2005). Therefore, this thesis presents answers to research questions, which might be different from the answers from another researcher.

Personal values and ideas have influenced the shaping of the research questions, and of course, also the methods of inquiry, reporting of results, and overall conclusions. The aim of this study and its overall purpose is also laden with values and judgments about what we ought to do for our environment and how what we ought to be educating our children about. Many traditions in the social sciences, unlike positivist approaches, allow for interpretation of “truths” and recognize the role of the researcher in shaping the research process. This statement merely means to clarify that the author recognizes these influences in this thesis.
3.2 Detailed Methodology

3.2.1 Research Context and Study Areas

The students sampled in this research project were all in the 7th grade, in the public school system in Ontario, Canada. It is important to note that the school curriculum is standardized for the province and by end of the 5th grade, students are expected to know how to “explain the difference between weather and climate and the factors that influence both of these systems (e.g., temperature, moisture, wind, air pressure, the sun)” (Government of Ontario 1998: 97). In this 5th grade, the “Earth and Space Systems” strand of the standardized science curriculum focuses on “Weather” (Government of Ontario 1998). Furthermore, at the end of the sixth grade, children are expected to understand how the earth’s rotation around the sun can affect seasonality and also changes in long term climates (Government of Ontario 1998). While there is no specific curriculum in any grade level that focuses on climate change, this study assumed that children in the seventh grade had a base knowledge of the difference between weather and climate (since they had learned about it in the 5th grade), and also of some of the forces that are responsible for natural variability in climate1. Any information that the children at this age might have about climate change, might have come from their parents, the media, or their school teacher, if the classroom teacher decided to incorporate climate change into the curriculum. It might have been an individual choice of the teacher to teach about climate change, because it is

1 At the time this thesis was written, the most current Ontario Curriculum (1998) did not include any regulations on teaching children about climate change. Since then, The Government of Ontario published an updated Curriculum for Public and Separate schools in 2007. This most recent curriculum places climate change in the curriculum, in grade 10 science, and students are expected to be able to identify impacts of climate change. This is the final grade level for which science is a required course for students in Ontario. The new curriculum mentions climate change in the 7th grade science curriculum, but only as one example of natural factors that can affect ecosystems. There is no formal learning outcome in the 2007 curriculum for climate change science.
not in their school curriculum. For example, a teacher with a keen interest in a subject matter that is not in the curriculum might choose to bring that subject into discussions about current events. The curricular context for this thesis is very interesting, as it allows for a comparison of children’s ideas about climate change with the understanding that they have passed a certain set of learning outcomes, which are similar across the province. In this case, the research is focused on assessing if there are any differences among children in rural, suburban, and urban areas, given that their formal schooling of the subject is the same in all areas.

One public school board from each type of area was selected to participate in this study. Each school board contained a range of school types. All of the school boards were in Ontario, Canada. Due to confidentiality at the request of the school boards, no identifying detail can be given about the locations of the school or the boards. However, three school boards participated in this study, and three urban, suburban, and rural schools participated.

For the purposes of this thesis, urban, suburban, and rural schools are defined as follows:

*Rural Area* – Statistics Canada (2007) defines all areas that are outside of urban areas to be rural areas. However, because suburban areas are also considered in this study, a more precise definition is required. For the purposes of this thesis, rural areas were considered to be those outside of the commuting area of a larger urban core, with population concentrations and densities that did not meet the requirements of Urban Areas (as defined by Statistics Canada (2007)). In order to be more specific to the exact school, postal codes were used as rural areas in Canada are designated by postal codes whose second digit is a “0” (Statistics Canada 2007).

*Urban Area* – Located within an urban core or city. Such areas have a population concentration of at least 1000 and a population density of at least 400 people per square
kilometer (Statistics Canada 2007). However in some cases, schools in Suburban Areas (SA) can also meet these criteria. Indeed, there is no exact definition of urban or suburban areas, as used by Statistics Canada (Turcotte 2008). For the purposes of this study, urban areas were defined as being within a municipality whose census subdivision type is defined as a “city” as opposed to a “town”, and also that are located within 25 kilometers of the city hall (Turcotte 2008).

Suburban Area – As stated above, due to the lack of consensus regarding the definition of a suburban versus an urban area, suburban areas in this thesis were defined as being part of municipality whose census subdivision type is defined as a “town” as opposed to a “city”, or is located within a “city” subdivision, but is more than 25 kilometers away from the city hall (Turcotte 2008). In these cases, if that area’s postal code contained a “0” as the second digit, that area was considered to be “rural” (see previous).

3.2.2 Confidentiality

Students’ names, school names, teachers’ names, and board names are kept confidential in this study at the request of the participating school boards due to the young ages of the research participants. In each board, three schools were either selected by the board administrators (as was the case for two of the school boards) or were approached by the researcher. If the schools were approached by the researcher, they were selected, at random, from a table of schools in that board. The first three schools that agreed to participate in this study were approached by the researcher. In each school, one class of grade seven students was asked to participate, for a total of nine schools.

Children are not legally permitted to provide their own written consent for participation in research studies, so parental consent forms were distributed by the classroom teacher and only
those students with signed consent forms were allowed to participate (see appendix for consent forms). Students were asked to provide illustrated responses in this research study and so part of the parental consent forms asked for the release of such illustrations to the researcher for academic publication and presentation. Those students without a signed release form were still invited to provide an illustrated response (to keep the class, as a whole, together) but these students’ illustrations were discarded.

In every case, students were informed that their participation was totally voluntary. That is, even with a signed consent form from their parents, they were not obliged to participate in any part of the study. Children of this age group are old enough to provide verbal assent, and so they were each asked, before each part of the methodology, to agree to participate or to opt to sit out the exercise.

3.2.2 Illustrated Responses

The first part of this research design sought out children’s illustrations of climate change. This was conducted before the open ended interviews and was the first point of contact between the children and the researcher. In each case, the students were not prompted or prepared by the researcher, and the teacher was also asked not to talk about the aim of this research project to the students before participating. This was in an attempt to minimize researcher and teacher influence immediately before the period of study. Any previous instruction from the classroom teacher regarding climate change prior to this study could not be controlled for.

Each class of students was asked to draw a response to the question “What does Climate Change mean to you?”. It is stressed here that participation in this study was completely voluntary, and that students were informed that the classroom teacher would not mark or even
view the responses. Students who did not want to participate chose quiet reading or work during this research period. It should be noted that only the responses from students who returned parental permission forms, granting the researcher with rights to these images, were used. The students were allotted between 20 and 30 minutes to complete their illustrations or written entries. A total of 88 illustrations with signed consent forms were collected, out of a possible 176 students who were asked to participate.

3.2.3 Open Ended Interviews

Following the collections of the illustrated responses, students were asked to volunteer for a 20-40 minute interview, and it was made clear that their participation had no impact, either positively or negatively, on their academic standing. A total of 78 of the 176 students volunteered for a an individual interview, which occurred on school grounds, often in a separate and semi-private space, such as in the library or in a resource room. The interviews were tape recorded, with the oral consent of the student, and data were transcribed at a later date (see appendix for consent script).

The questions in the interview were meant to elicit responses regarding the children’s thoughts of climate change through a series of stages. The first was identification of the issue(s), followed by descriptions of the causes, followed by the anticipated effects of climate change and then finally climate change mitigation. Students were allowed to skip questions, and also revisit them later if they decided to. It can be speculated that the reasons why a student would choose to skip a question could be quite varied. These could include not understanding the question, not knowing the “answer” (or being unsure of the answer), or simply wanting the interview to speed along. In no case did a student ask to cease the interview, although this option was clearly made
to them at the outset of the interview. In some cases, due to time constraints, interviews spanned over two days, when either the classroom period or school day came to a close. In these cases, the interview reconvened within one or two days in the next appropriate time slot. The following questions were used as a guide for the open-ended interviews. It should be noted that the first six questions were included to ease the student into the interview situation, by offering relatively innocuous questions. Table 1 summarizes these questions, highlighting those questions that were used for this thesis.

Table 1: Open-Ended Interview Questions for Students in the 7th Grade

<table>
<thead>
<tr>
<th>Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are animals important in your life?</td>
</tr>
<tr>
<td>Are plants important in your life?</td>
</tr>
<tr>
<td>Are you aware of any environmental problems? Which ones?</td>
</tr>
<tr>
<td>What kinds of things do you do to help the environment?</td>
</tr>
<tr>
<td>What do you think “weather” means?</td>
</tr>
<tr>
<td>What do you think “climate” means?</td>
</tr>
<tr>
<td>Have you heard about the greenhouse effect? What have you heard about it?</td>
</tr>
<tr>
<td>Have you heard about climate change? What have you heard about it? What do you think causes it?</td>
</tr>
<tr>
<td>When or where do you think it might happen?</td>
</tr>
<tr>
<td>Who might be affected by climate change? How?</td>
</tr>
<tr>
<td>What do you think you, your friends, or your family can do to help?</td>
</tr>
<tr>
<td>Who else might be able to help? How?</td>
</tr>
</tbody>
</table>

*Note – Questions 1-4 were not analyzed in this study, but were meant to allow the student to become comfortable and familiar with the researcher.*

These questions were a rough guideline for the interviews, and in all cases, the students who participated in the study were asked all of these questions, in order. However, due to the open-ended nature of the interviews, the questions were explained or elaborated upon. For
example, some students may have responded that they had not heard of climate change. In these cases, the interviewer would refer back to the illustration that the student had provided. In most cases, this began a dialogue between the researcher and the student. The interviews were conducted in a conversational style and most students were very open and eager to participate in the one-on-one interviews. The students responded very well to the questions, indicating that the level and language was well-suited to this age group.

It should be noted that while there might be debate among climate researchers as to whether or not the term “global warming” ought to be used rather than “climate change”, such debate is beyond the scope of this thesis. However, I would point out that if we are to discuss the impacts of increased greenhouse gases from anthropogenic sources, resulting in changes in atmosphere-ocean circulation, then the term “climate change” is much more appropriate as we are concerned with not just increased temperatures (and indeed, some areas may experience decreases in temperatures) but also climatic changes such as increased precipitation, droughts or extreme weather events (IPCC 2001). Therefore the term, “global warming” might evoke different ideas and emotions in research subjects than “climate change”. However, asking about mitigating effects of “global warming” might be more accessible to children and teens.

3.3 Description of Data Analysis

The illustrations and interview data were treated as separate groups of data for two main reasons. First, one of the aims of this thesis is to understand the utility of different methods, including illustrations and interviews, in seeking out children’s ideas about climate change. In order to do this, the two data sets were examined separately, so that the findings could be compared from one method to the other. Second, the illustrations were not referenced in the
interviews themselves, unless the student was exhibiting difficulty in articulating their thoughts about climate change. For example, if a student said that they “did not know” about climate change, reference was made back to the illustration to refresh that student’s memory of the illustration they had just provided. However, for the most part, the illustrations were kept separate from the interviews to avoid instances where the student might want to change their illustration, or attempt to attach a verbal description of their drawing. The illustrations were meant to provide “snapshots” of the students’ initial mental images of climate change. Once the interviews had commenced, the research method had moved from this static “snapshot” into a more dynamic and conversational methodology, involving more of the researcher and any subconscious bias that a second person introduces into an interview. Therefore, these two data sets were kept separate as much as possible at stages of data collection.

3.3.1. Illustrated Responses

The illustrated responses were collected and given an identifying mark on the backside of the illustration, with the name of student’s school. Once all the images were collected, they were then scanned as electronic image files. The files were put into a slide show and viewed without the identifying marks. The viewing of the files was at a random setting, which changed every time the slideshow was completed. In the first three viewings, no notes were taken, and then in subsequent viewings, notes were taken as to some of the emergent themes. After multiple viewings, the main themes were identified and the images were grouped accordingly.

From these main themes, images were chosen as examples in this thesis to provide (as much as possible) a random and representative sample of images from different children, in
different schools, and in different school boards. However, due to confidentiality, these identifying characteristics are omitted from this thesis.

3.3.2. Open-Ended Interviews

A total of 78 interviews were completed and tape recorded (with permission from the participant). The tape recordings were transcribed into word documents by two different work study students, under my supervision. Each of the students double-checked the other students’ work for accuracy. These word files were imported as documents into NVivo7, a software package designed for qualitative analysis of open-ended data. The process of coding data is core to the use of grounded theory. In fact, the term “In Vivo” refers to “hot” phrases or “key” phrases that a study group might often give in their interviews (Charmaz 2006). These “hot” phrases are coded “In Vivo” and provide the point of departure for themes and ideas to group together through these new codes.

In the case of this research, each of the transcripts was read by the researcher as a whole, two times before any coding began. Following this entire reading, the data were read question by question once more time. Key words and themes were identified and coded into “free nodes” of unrelated and ungrouped information. Each question was read several times (from three to ten) and key words and phrases were repeatedly coded. In some cases, the codes may have changed, and by the end of the reading, the codes were set into a set of these “free nodes”. NVivo7 was then used to create “tree nodes” of similar and related codes, for example, of all codes related to “littering” or of the different responses to the question “what are the causes of climate change?”.
The main themes from each question were brought into family nodes to indicate the types of responses that occurred. For each type of response, the number of responses from children in each area were counted and tabulated. Quotations were selected as examples in this thesis to be as representative of as many different students as possible, and also to be as representative of each area type as possible.

It should be noted that all of the free nodes (codes of data) were used in the final analysis. While most of them ended up as a grouped “tree node”, a few were found, through continuous re-reading of the data, to be unrelated to other nodes and thus remained as free nodes. This distinction does not change the significance of the codes, but rather only affects the number of final codes that were used in the study. All of the codes were still used in the final analysis, so that none were omitted on the basis of number or frequency. It was important to highlight the range of responses given, and their frequencies are given in the subsequent chapter. These approaches of seeking out a full range of respondents and also the systematic approach of data analysis are consistent with the qualitative research “best practices” as suggested by Mays and Pope (2000).

3.3.3. Chi Square Testing of Between Group Differences

While the general approach of this thesis is qualitative and uses grounded theory as method of analysis, another method was used to aid in the data analysis. This is consistent with many social science research traditions, which use triangulation, a method of combining more than one method of analysis, to confirm or reject significant findings (Mays & Pope 2000). While the data could have been analysed simply though the reading and re-reading of codes, some statistical methods were also employed to test for any differences between the three groups of
children in this study. Because the sample size met the criteria for analysis, one-way chi square tests were run for the data sets to determine if the differences observed between groups (suburban, rural, and urban) were statistically significant or not. This test was chosen due to the qualitative nature of the data. In addition, the choice of grounded theory as a research approach, which allows for some quantification in the data, paralleled the use of some statistical methods in the data analysis. In each test, the null hypothesis stated that the probability of any given response was equal for each school area. This was stated as:

\[ H_0: P_{\text{Urban}} = P_{\text{Suburban}} = P_{\text{Rural}} = 0.333 \text{ (or 1/3)} \]

and that,

\[ H_A: H_0 \text{ is false} \]

The test compares the observed frequency with the expected frequency. The expected frequency is calculated by taking the product of the sum of the total number of responses for each category and the sum of the total number of responses from each group of students and dividing that product by the total sample size. For example from Table 2 in the Results and Discussion chapter, the expected frequency of urban students who will submit an illustration of the four seasons as a depiction of climate change is calculated by multiplying the total number of urban students’ illustrations and the total number of illustrations of the four seasons, and dividing that product by the total number of illustrations submitted. The expected frequency in this case is then 4.09. This implies that on average, for this sample size, one could expect that 4.09 students in urban areas would submit an illustration of the four seasons as climate change, among a population of 88 students.
The chi square itself is calculated as the sum of the squared differences between the observed and the expected frequencies, divided by the expected frequency.

\[ x^2 = \left[ \sum (f_o - f_e)^2 \right] / f_e \]

The resulting chi square can be compared to the critical values of \( x^2 \) for the corresponding degrees of freedom (in this thesis, \( df = 2 \)) at various levels of significance. It is general practise that the chi square test only be conducted for average expected frequencies of 5 or higher and extremely large or small sample sizes ought to be avoided (Witte and Witte 2000). Again in the case of Table 2, while the \( f_e \) of urban students submitting illustrations of the four seasons was less than 5 (\( f_e = 4.09 \)), the average expected frequency for this category of illustrations is 6.0, as the expected frequencies for suburban and rural children are higher.

Chi square tests were conducted for all interview questions and groups of illustrations with expected frequencies of 5 or greater. Probabilities less than 0.05 or 0.01 indicate statistical significance at the 95% or 90% level of confidence, respectively. This is done to discern differences that might exist among rural, urban, and suburban groups of children.

3.3.4 Relevance to Research Questions

These data and data analyses were used to answer the main research questions. The first question, “How do children, aged 11-12, perceive climate change and climate-related risks?” was answered by examining the main themes that emerged from both the illustrations and the open-ended interviews. These main themes signal the ideas that children have about climate change itself, as well as its causes, effects, and strategies for mitigation. This is related to the
overall conceptual framework for this thesis, as it seeks to understand the cultural influences (if any) that affect how these children, as a group, understand climate change.

The second research question, “Do any differences exist between students in rural, urban, and suburban areas of Ontario, Canada?” was examined by comparing the frequency of the types of responses in each theme and using the chi square test to see if any significant difference existed between groups. This test was conducted on the illustrations as well as the interview questions. This is also related to the overall conceptual framework of this study, as it seeks to understand how place might influence children’s worldviews of climate change.

The third research question, “How do these perceptions and ideas differ from those of adults, as found in the literature?” was answered by comparing the main themes that emerged from the students’ illustrations and interview data, with the main conclusions and themes about adult perceptions of climate change, as found in some literature. The children’s data were compared to see if any new themes emerged, that did not appear in the literature on adults, or to see if any ideas from the literature on adults were not prevalent in the children’s data sets.

The final research question, “What are the merits of qualitative research methodologies, in understanding children’s ideas about climate change? Do less traditional methods, such as illustrations, make a new contribution to research methods with children?” was examined by comparing the information and ideas from the illustrations to the ideas from the open-ended interviews to see if any new information was gained in one method, when compared to the other.

3.3.5 Limitations of the Methodology
As with any study, the methodology used in this thesis is not without its shortcomings. In many cases, attempts to compensate for these limitations are made whenever possible. Pre-exposure bias was limited by asking the classroom teachers not to discuss the purpose of the research project beforehand.

Parental consent may have hindered the number of students available to participate in the study. The time of day may also have affected students’ willingness to volunteer for a one-on-one interview. For example, students may be less apt to volunteer during one type of lesson (e.g. art or physical education) than another (e.g. math or quiet reading). Also, while the students were asked not to discuss their interviews with their peers, it is difficult to determine whether or not children shared information before each interview.

In addition, artistic skill may have hindered some children’s illustrations, if the student was not particularly comfortable with his or her ability. In these cases, the children were assured that they could use some words to help describe their illustrations. Figure 2 is an example of one illustration that also features some written explanation from the student.
Figure 2 – An example of an illustration of climate change, showing the use of words to help describe their illustration

In this case, the student used words to describe the images in their illustration. There may still have been some cases, however, in which student’s perceived a limitation in their artistic ability, which may have affected the final illustration that they submitted.

The limitations in the interviews and the illustrations to gather information from the students about climate change were adjusted for in some cases. However, willingness to
participate may have been affected by other factors, and the design of the research, while meant to
draw out the students’ ideas, might not have been the best methodology for every student,
depending on the individual’s comfort level and verbal or illustrative communication abilities.
4. Research Results and Discussion

This chapter presents both the research results as well as discussion of the significance and importance of the research findings. First, the results of the illustrated responses are presented and discussed. The images were coded into themes, based on their content. Due to the large number of illustrations, only a few samples are shown from each of the themes as examples of the types of data collected. Second, the results of the open-ended interviews are summarized and discussed, by question. These indicate the main responses and ideas found in the interview data, and are separated by question to demonstrate the differences in ideas about climate change, its causes, its effects, and strategies for mitigation. Several excerpts are included to give depth and feeling for the students’ responses, as opposed to just presenting the coded responses. Following this, the two methods of illustrations and open-ended interviews are compared and the merits of each are discussed.

The results of the statistical analysis (chi square test) are then presented, to help determine if there are any differences between the urban, rural, and suburban students and their ideas about climate change, as determined from the interviews and the illustrations. This section of the chapter also discusses these results, to assess the significance of place and its impact on children’s ideas about climate change. The last section discusses the differences and similarities between children’s ideas about climate change and adults’ perceptions, as found in some of the literature, most particularly by Kempton (1997), Pendergraft (1999), Mortsch et al. (2000), and Leiserowitz (2004, 2005, 2006).
4.1 Illustrated Responses

4.1.1 General Themes of Climate Change from Children’s Illustrations

A total of 88 illustrated responses were collected in the three school districts. The illustrations were coded into one of five different themes. These themes were not preconceived, but rather emerged from the data through grounded theory, as described in Chapter 3.

From all of the illustrated responses, five main themes were drawn out from the content of the drawings. Each of these themes was found to be mutually exclusive through a simple content analysis. That is, none of the illustrations were coded as more than one theme. One would imagine that a student could have illustrated both the four seasons as well as environmental pollution, but that was not the case in any of these 88 illustrations. For each of the illustrations, the themes were all clearly defined. This would suggest that the themes were exclusive of one another, with no overlap. There are five general concepts that students associate with the phrase “climate change”. This is not to say that if given more prompts or explanations, the students would not have a more detailed understanding of the greenhouse effect, greenhouse gases, causes and effects, or other popular knowledge. These images, rather, provide insight into the mental images and “snapshots” of these children’s initial ideas of climate change. In the case of the illustrations from the children, none were coded more than once. The themes, while not mutually exclusive (as it could be conceived that an illustration could overlap in themes) as they emerged from the illustrations, were:
• Weather Change
• The Four Seasons
• Climate change
• General climate knowledge
• Pollution

Student’s illustrations were not evenly distributed across these five themes. A total of 38 illustrations from rural students, 30 from suburban students, and 20 from urban students were collected. Table two summarizes these distributions by school area.

Table 2: Illustrations of Climate Change Grouped by Thematic Response: Frequency by Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weather Changes</td>
<td>7</td>
<td>14</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>The Four Seasons</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Climate Change</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>General Climates</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Pollution</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>30</td>
<td>38</td>
<td>88</td>
</tr>
</tbody>
</table>
4.1.1.1 Weather Change

Illustrations that depicted a change between two states of weather, rather than climate, were coded as “weather change”. This could be a change from morning to night, from rain to sun, from one day to another, or from one location to another. These were clearly different than illustrations showing a seasonal change, as grouped in the second theme. Figures 3 and 4 depict examples of images coded in this first theme.

Figure 3 - A Rural student’s illustration of “weather change”, depicting changes from high to low temperature, cold to warm clothing, and sunny to stormy conditions
Figure 4 - A suburban student’s illustration of “climate change”, depicting changes in weather from sunny, to stormy, and back to sunny again

It would be expected that students in the 7th grade would be able to recognize this fundamental distinction between a change in weather and a change in climate. However, nearly 56% of the respondents chose an illustration of a change in weather as a response to the question “what does climate change mean to you”. These illustrations depict such changes as from hot to cold, a clear day to rain storm, or a snow storm to a cold winter day. None of these weather
changes are similar to what scientists would refer to as a change in climate, either natural or anthropogenic.

This confusion between a change in weather and a change in climate is not unique to children of this age group. Other researchers indicate this very common perception among adults (Kempton 1997) where changes in weather are often mistaken as signals of climate change. In this study, the illustrations indicate in more simplistic terms, the connection, or confusion, between a change in the weather and a change in a climate. This confusion is a major concern for several reasons. If students are unable to differentiate between the two, their perceptions of climate change are skewed. There is a potential that daily changes in the weather, which are not viewed with any major environmental concern, can be synonymous with more severe changes in climate, causing students to be insensitive to discourse about climate change. If weather changes every day or even several times per day, there is no real cause to be concerned about “climate change” if these are, in fact, the same phenomenon. In addition, if changes in weather are seen as indicative of climate changes, changes in weather can be viewed as signals of global climate change. Severe storms, cold spells, heat waves, or dry periods are normal characteristics of “weather”. Attributing each unfriendly day or unseasonable week to climate change is misleading. Natural perturbations or seasonal anomalies are not always attributable to anthropogenic climate change. This issue is becoming increasingly important as climate change is becoming more popularized through media, movies, documentaries, and television. Either through the insensitivity or hypersensitivity of weather as related to climate change, students are still confusing the link between weather and climate.
4.1.1.2 The Four Seasons

Illustrations that depicted seasonal changes were coded as “the four seasons”. These drawings capture the seasons as they are observed in the Northern Hemisphere - a change between cold winters and warm summers, with moderate spring and fall seasons in between. In order for an illustration to be coded in this category, it must have shown some kind of change between seasons, either between winter and summer, or all four seasons. Figure 5 depicts an example of an illustration coded as “the four seasons”.

*Figure 5 - A suburban students’ illustration of a tree across the four seasons of winter, spring, summer, and fall*
Figure 6 - An urban student’s illustration depicting various activities and weather changes associated with the four seasons

Figure 6 also illustrates this seasonal transition. Illustrations of a seasonal change in climate were the second most popular response from the students. Nearly 23% of the responses were illustrations of either the four seasons (as they are observed in Southern Ontario) or of a distinction between two seasons (i.e. summer and winter). Again, the 5th grade curriculum in Ontario addresses the distinction between weather and climate. This second theme is perhaps more “correct” than the previous theme of “weather changes”. Certainly, the climate (if defined as a seasonal average) does change four times per year in Southern Ontario. But just as
certainly, the term “climate change” is most often meant to refer to human induced changes to the overall average climate in an area or the entire globe.

If students perceive seasonal change as climate change, then there is little to be concerned about when they hear about climate change in the news or at school. Seasonal change (formally taught to children in Ontario as early as the first grade (Government of Ontario 1998)) is a regular change that is part of nature.

The idea of climate change as a seasonal change was evident in the literature of adult perceptions of climate change, though not as pronounced (Kempton 1991; 1997), indicating that this sample of students is different in this way. Kempton (1991; 1997) found that in the minority of cases, adults used seasonal weather variations to explain and understand climate change. However, they did not represent seasonal changes in the same way as the children did in this study. In this thesis, the children used the four seasons to explain climate change, whereas Kempton (1991; 1997) found that adults tend to confuse seasonal anomalies (e.g. an especially cold winter or warm summer) as indicators of climate change. The adults did not tend to use the model of the four seasons that we observe in the northern hemisphere as an explanation of climate change.

The children’s ideas of climate change as a seasonal change in weather is far removed from the idea that climate change is a long term change in climate due to human influences on the environment. This process indicates that the children in this study recognized that there was something inherently similar between seasonal changes in weather and long term changes in climate. While this may not align with the current scientific consensus of climate change, it does show that some recognition has taken place.
4.1.1.3 Climate Change

Climate change, as a theme of children’s illustrations, refers to those illustrations that depict one or more aspects of what the scientific community would consider as being related to the issue of “anthropogenic climate change”. These could include aspects such as glacial melting, carbon dioxide emissions, loss of northern habitat, the migration of disease vectors, or rising temperatures. Some of these illustrations included more than one aspect, such as increased temperature and a loss of northern habitat. Figure 7 shows an example of one of these illustrations.

Approximately 16% of the respondents illustrated some ideas or concepts related to what the scientific community would refer to as “climate change”. Some of the concepts included increased greenhouse gases (which are different than a general blanket theme of “pollution” which is to be covered later in this section), melting ice, polar habitats, increased global temperatures, changes in disease patterns, sea level rise or ozone depletion. While this last concept, ozone depletion, is not related to the issue of climate change (Harvey 2000), it is commonly misconceived as so by the public, and so was included in this theme of climate change. The rationale for this was also because the illustrations depicted an increase in solar radiation due to depleted ozone, resulting in increased temperatures. While scientifically, this is not correct, the illustrations describe a key aspect of climate change; increased temperatures.
Figure 7 – A rural student’s illustration of several aspects of “climate change”, including a politician, migrating diseases, increased temperatures, polar ice melt, greenhouse gas emissions and the displacement of wildlife.

It is important to look more closely at these illustrations. The illustrations all depict some kind of negative impact or cause of climate change. This is synonymous with the general risks associated with climate change, as perceived by the general public (Leiserowitz 2005). Climate change is seen by these students and very often by the general public as a risk and hazard. This is significant because all of the students’ illustrations that were coded into this theme addressed some issue related to risk or hazard. It may be difficult to perceive an illustration of climate change that does not relate to risks and hazards. However, one might just as easily depict a caricature of energy efficiency, international agreements and protocols, important politicians or
spokespeople associated with climate change, or the general science behind human-induced climate change. The students in this study who submitted an illustration more closely related to the scientific understanding of climate change created pictures depicting a hazard or a risk.

Another type of illustration that was coded in this group of “climate change” included illustrations of extreme weather or atypical weather patterns, which are also expected in future climate changes (Harvey 2000). Figure 8 is an example of this type of illustration.

The total number of illustrations in this category of “climate change” is also important. Sixteen percent of the illustrations submitted were considered to align with the scientific consensus of climate change, while other types of illustrations constituted the majority of the children’s submissions.
Figure 8 – A suburban student’s illustration of children expressing disbelief over atypical weather events, including a fast change from snowy to sunny conditions, snowfall in the summer and a thunderstorm with no rain.

4.1.1.4 General Climate Knowledge

This theme refers to illustrations that depicted some aspect of general climate knowledge, such as ocean circulation, planetary orbit, or general patterns in climate. This theme does not include illustrations depicting a particular change in climate, but rather a demonstration of knowledge that climates are variable, and are due to larger scale global forces. Figures 9 and 10 are examples of illustrations that depict some kind of general climate knowledge.
Figure 9 - A suburban student’s illustration of general climate knowledge, depicting the rotation of the earth in relation to the sun.
Nine percent of the students’ responses illustrated some kind of scientific understanding of climates in general. These include concepts such as global circulation, oceanic circulation, or differences in global climatic regions. These responses demonstrated an understanding of climate as a scientific term as it was likely taught to them in the fifth grade of their science curriculum (Government of Ontario 1998). The connections between climate and climate change are not depicted in these illustrations. In fact, no change in climate was depicted in these illustrations, rather only the mechanics of how climate is influenced by global circulation patterns.
4.1.1.5 Pollution

This last theme refers to illustrations that depicted some aspect of environmental pollution. This includes illustrations of garbage, air pollution, car exhaust, and water pollution. While some illustrations grouped under other themes may have included some illustrations of pollution (for example, an illustration of car emissions and also a thermometer showing an increase in temperature along with a melting of polar ice would have been grouped under the theme of “Climate Change”) the illustrations grouped under the theme of “Pollution” emphasized some kind of pollution.

Six percent (5 of N=88) of the sample were coded into this last theme. These included illustrations of garbage, smog, CFCs, or even terrorism. While terrorism is not what one would generally think of as pollution, it does indicate an unwanted or hazardous presence. In these illustrations, climate change is viewed as a hazard. While the students may not be able to accurately depict this hazard in scientific terms, another environmental risk is illustrated. Figures 11 and 12 are examples of this type of illustration.
Figure 11 - An urban student’s illustration of “pollution”, depicting weather-related events, a factory, and human-made missiles or bombs
Figure 12 – A rural student’s illustration of “pollution” depicting a nuclear factory, “The Bay”, and a factory

Although a relatively small portion of the illustrations, these six percent highlight an important theme of the children’s ideas about climate change. The negative feelings of these images are not balanced by any positive images in the entire sample. While some could be interpreted as “neutral” (for example, the images of seasonal changes), there are none that depict any optimism or hopefulness associated with climate change.

This theme of pollution is also found in the literature as a popular cultural model in adults (Kempton 1991, Kempton 1997, Leiserowitz 2006). It is a way in which the public views the causes of climate change as human-induced, and also negative.
In summary, while some of the main themes from these illustrations were similar to the cultural models found in adults (including weather changes, climate change, and pollution), others were not. The different themes included climate change as “seasonal changes”, and “climate systems”. The illustrations indicate that there are some differences between children’s and adults’ ideas about climate change. However, the process of using existing knowledge of climate to explain “climate change” is very similar to the process used by the adults in Kepmton’s (1991) study.

4.2 Open-Ended Interviews

The open ended interviews revealed many important issues and concepts regarding children’s ideas about climate change. Contrary to the illustrated responses, the interviews (which always occurred after the illustrated responses to limit research influence on the illustrations) allowed the researcher to interact more with the students, and to ask for clarification, and also provide clarification if questions were not understood. The major themes that emerged from these data suggest that children do have familiarity with environmental and climate information, which are sometimes used as cultural models of students’ understanding of climate change. It should be noted that some interviewees are counted more than once, as they may have spoken to more than one idea within a given theme. These data summaries are presented in order to indicate the frequencies of responses. For example, one student might describe the Greenhouse Effect as being both related to global warming and the ozone layer. Therefore, this student’s response would be counted twice, under both global warming and the ozone layer. Because some students’ responses were counted twice, summaries of the number of
occurrences in each theme are presented, as opposed to percentages. These data counts are also presented by location, that is, if the student was from a rural area, suburban area, or urban area.

4.2.1 Summary of Major Themes from Open-Ended Interviews

Four major themes were explored, as they emerged from the interview data. These are: explanations of the “greenhouse effect”, descriptions of climate change and global warming, the impacts of climate change, and options for mitigation. It should be noted that the responses for the first six questions of the interviews were not used in this study, as they were meant to just familiarize the student with the researcher, through relatively innocuous questions.

4.2.1.1 The Greenhouse Effect

The children interviewed were asked to explain if they had heard of the greenhouse effect. If said that they had, they were also asked to expand upon this by describing what they knew about it. It is important to note that this question was immediately following a question on the meanings of the words “weather”, and “climate”, which can give the respondent an indication that the greenhouse effect is somehow related to these concepts. Four main response types emerged in the coding of the data. These were: uncertainty regarding the greenhouse effect, that the greenhouse effect is related to global warming, that the greenhouse effect is related to ozone depletion, and that the greenhouse effect is related to pollution. Table 3 summarizes the frequency of these responses, by respondents’ school area. This table reveals that most children said they had not heard of the greenhouse effect. It is important to note that while 78 interviews were completed, only 55 children answered this question. Students were allowed to “pass” questions if they were unsure of what to reply. Therefore, while 30 students stated that they were not sure of or had not heard of the greenhouse effect, it can be speculated that many of
those children who “passed” on this question were also unsure. This indicates that 38% of the students said they had not heard of the greenhouse effect and actually 55% of the students who answered the question gave this response. Since this question occurred relatively early in the interview process, many children were perhaps also shy or unsure of the interview situation itself. In these cases, the interviewer did not want to lead the responses, and so no clarification was given.

Table 3: Descriptions of the Greenhouse Effect: Frequency by School Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t know</td>
<td>7</td>
<td>7</td>
<td>16</td>
<td>30</td>
</tr>
<tr>
<td>Related to Global Warming</td>
<td>2</td>
<td>8</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Related to Ozone Depletion/Ozone Layer</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Related to Pollution</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>21</td>
<td>21</td>
<td>55</td>
</tr>
</tbody>
</table>

Knowledge of the greenhouse effect and its role in the earth’s climate is fundamental to understanding climate change. Andersson and Wallin (2000) and Koulaidis and Christidou (1999) suggest that this base knowledge is key to children’s (and also adults’) scientific comprehension of greenhouse gas emissions, and their effects on the global climate.

The second most frequent response to this question was that the greenhouse effect is related to global warming (18% of the sample and 25% of the students that responded to this question).
For example,

*Suburban Student* - “It’s almost the same as global warming it is the same as global warming the greenhouse effect is like a visual. Cause like the sun’s rays enter the greenhouse and the warmth bounces around the greenhouse to let the plants grow and they are saying that the earth is like a giant greenhouse with the carbon dioxide on the outside that stops the warmth from going back out.”

*Urban Student* - “Similar to the global warming actually, greenhouse effect is the greenhouse gases is in the air and it causes holes in the ozone layer... global warming.”

These students made a connection between the greenhouse effect and what scientists would consider to be anthropogenic climate change. The first student actually stated that the greenhouse effect is “like a visual” and is likely remembering popular educational images of the greenhouse effect, shown as an “imaginary shield” within the earth’s outer atmosphere. The second student, while confusing the greenhouse effect with ozone depletion, was still aware of the relationship between greenhouse gases and global warming. While it could be interpreted that there was some confusion in both statements, these students were sure of atmospheric and climate-related implications of the greenhouse effect. Other studies have also found that adults generally tend to connect the greenhouse effect to some type of atmospheric or climate-related effect (Kempton 1997, Andersson and Wallin 2000, Mortsch, et al. 2000, Lorenzoni and Pidgeon 2006).

Ozone layer depletion has been highly publicised as an environmental issue related to human health within the past few decades and its impact has permeated other environmental-atmospheric discourses. The third most frequent response was that the greenhouse effect was
related to the ozone layer or ozone depletion. Here is it important to note that some responses may have been counted twice. For example, the response documented above would have been coded as being related to both global warming and climate change. Other students may have stated that the greenhouse effect was related to stratospheric ozone depletion, but not specifically global warming or climate change. For example,

Suburban Student - “It’s about air pollution going on in the ozone layer creating a hole, so that sun rays can get through it, so it isn’t as protected.”

In total, 9% of the students (16% of the students that chose to answer this question) responded in this category. While not a high frequency of responses, it does indicate that some children do have ideas about the greenhouse effect and its connection to other atmospheric issues, such as ozone depletion.

The least frequently given response was that the greenhouse effect is related to the blanket term of “pollution”. This blanket term occurs frequently throughout this study (as responses to other questions in the open-ended interviews and also in the illustrated responses) and is problematic because it is evident that “pollution” can refer to several different sources of pollution, which are not always related to climate change. As a social construct, this term is worthy of some more analysis, but that discussion is beyond the scope of this thesis.

A total of 5% of the students interviewed (7% of the students who chose to answer this question) gave responses in this category. While at first this seems a rather low frequency, it should also be noted that these were open-ended interviews, with no pre-set list of responses. In recognizing the infinite number of responses that students could have given to this question, four
of them gave a common response that the greenhouse effect is simply related to “pollution”. For example,

*Rural Student* - “There is too many toxins going in and ruining the atmosphere. And I think they call it the greenhouse effect

From these observations of children’s ideas about the greenhouse effect, it is clear that those students who did decide to respond to this question, but did not state that they did know about the greenhouse effect, all relate it to some aspect of the earth’s atmosphere.

### 4.2.1.2 Children’s General Ideas about Climate Change

Children were also asked to describe what climate change was. Two of the children asked to skip this question, and so 76 of the 78 students who were interviewed, gave a response. In 19 cases, children stated that they did not know what climate change was or were unsure of what climate change was. Upon further prompting, some of these children were able to give a response, and those results are summarized later in this chapter. Table 4 summarizes students’ initial responses to, “have you heard of climate change”.

<table>
<thead>
<tr>
<th>Have not heard of climate change</th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have heard of climate change</td>
<td>15</td>
<td>27</td>
<td>15</td>
<td>57</td>
</tr>
</tbody>
</table>

*Table 4: Students’ Familiarity with the term “Climate Change”: Frequency by School Area*
Students who said they had heard of climate change were also asked to discuss their ideas about climate change. Many students, though stating that they had heard about climate change, were not able to give a definite answer as to what it was. For example,

Researcher - “Have you heard about climate change?”

Urban Student – “Yeah, in science class.”

Researcher – “What have you heard about it?

Urban Student – “They just said the word, they didn’t explain anything to us”

Conversely, some students who originally stated that they had not heard about climate change later revealed that they did have some ideas of what it was. In eleven of the 19 cases, students were able to discuss their ideas about climate change after being shown the illustration they had created prior to the interview. For example,

Researcher – Have you heard of climate change?

Urban Student – No.

Researcher – Have you heard of the phrase, climate change?

Urban Student – No.

Researcher – What do you think it means?

Urban Student – Change of temperature in like, storms and stuff.
Researcher - So when I asked you to draw a picture of what climate change means to you, you drew this, right? Can you describe it to me?

Urban Student - Um well yeah because um more people swim and they get hotter and then they’d be using more electricity because it’s more hotter in the summer and then um. In the winter there’s less like, it’s kind of like global warming, and it’s like less ice so I guess polar bears and walruses will be at the same place but they usually, walruses would be at a different place because they don’t want to be eaten, so that kind of forces them to be together.

In these cases, the students were then able to answer the remaining questions about climate change. While this urban student had stated that he (masculine forms are used only to keep confidentiality and not to identify gender) did now know about climate change, he was able to discuss it in the interview after being shown his illustration. Figure 13 is a copy of this student’s illustration, which clearly does show some knowledge of climate change issues.
Figure 13 – An urban student’s illustration of “climate change”, who stated that he did not know what climate change was, when asked in an open-ended interview.

In the other eight cases, three students were able to give some discussion of climate change after reference was made to global warming. This was brought up only when the student had already brought up global warming, either in their illustration, or earlier in the interview, when they were asked to discuss any environmental problems they had heard about. For example,

*Researcher – Have you heard of climate change?*
Rural Student – I heard it before but I didn’t really pay attention, like when my mom and dad were talking about it.

Researcher – So on the side of your drawing, you wrote “climate change means when the temperature is changing and the south and north poles are melting”.

Rural Student – Yeah, I got it mixed up with Global Warming

Researcher – So you think climate change and global warming are the same, or are they different?

Rural Student – I think that they’re…well I guess that they would be the same.

This excerpt continues with the student discussing what he thinks is global warming, because he referenced it in his illustration.

The results indicate that more students have heard of climate change than of the greenhouse effect. In fact, over twice as many students stated that they had heard of climate change. Not all of these students were able to elaborate on their ideas about climate change, and with some prompting from their illustrations, some students who originally stated that they did not know what climate change was, were able to elaborate on their ideas. In total, 41 of the respondents were able to articulate some thoughts about what climate change was, as indicated in table 4. When asked if they knew about climate change, caution was taken by the interviewer to exclude use of the term “global warming” (except in cases where the student had already brought it up), though students often responded with some reference to global warming. For example,
Suburban Student - “I’ve heard that you know global warming is making the polar ice caps melt, causing the water levels to rise dramatically like that is making the regions warmer it makes the climate there change. I’m not really sure how.”

This indicates how, when asked specifically, “Have you heard about climate change? If so, how?” one respondent heard the phrase “climate change” and responded with, “global warming”. While indeed very closely related, the two terms are not seen as synonymous within the scientific community. Climate change is actually a much broader term to describe a range of causes and effects of global changes in climate. As stated at the outset of this thesis, it refers to present-day changes and future (50-100 years) changes in climate due to increased greenhouse gases from anthropogenic sources. While global temperatures are expected to increase, scientists are also concerned with temperature decreases, changes to precipitation patterns, and other climate-related impacts (Harvey 2000).

After asking about student’s familiarity with climate change, the students were then asked to describe what they thought climate change was, or to say anything else that they knew about climate change. Table 5 summarizes the students’ main ideas, grouped by area and frequency.
Table 5: Students’ Initial Ideas about Climate Change: Frequency by Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Related to the Ozone Layer</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Rapid changes in weather or location</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Related to the four seasons</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Climate Change</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Similar to “The Day After Tomorrow”</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>10</strong></td>
<td><strong>18</strong></td>
<td><strong>41</strong></td>
</tr>
</tbody>
</table>

Twelve of the 41 students (30%) who were able to articulate some thoughts on climate change referred to the ozone layer or ozone depletion. For example,

*Rural Student* – “It is killing out our ozone layer and making it really too much heat on the environment.” and,

*Urban Student* - “It’s been getting a lot hotter out in the summer because of the ozone being destroyed by the gases and in the winters it’s been getting a lot colder, or it’s either been getting a lot colder or milder and our winters are getting shorter.”

This is dissimilar to the results of children’s ideas of the greenhouse effect, where the ozone layer was a relatively infrequent response, demonstrating students connected ozone depletion to climate change more often than they did to the greenhouse effect. The depletion of
the ozone layer is an environmental issue that has been taught extensively in schools (Andersson and Wallin 2000) and so some students draw from that knowledge to create a framework to understand other environmental issues, as many adults do (Kempton 1997).

The second type of response from students about their ideas of climate change was related to weather changes, as opposed to climate changes. These tended to be relatively rapid and observable changes either in weather or in place (i.e. moving from one location to another can often result in a change in weather or climate). For example.

*Urban Student – “Climate change means to me that the weather has a change from cold to hot even if it is a drastic climate change like from minus 10 degrees Celsius to 16 degrees Celsius in a day.”*,

*Rural Student - “It’s raining and then 10-minutes later it’s nice and sunny.”* and,

*Urban Student - “It means to me it is when the earth changes and weather changes too. Like when it turns into cold and hot and warm. Like the weather changes a lot of times.”*

Eleven of the 44 students (25%) who answered this question described climate change in relation to a rapid change in weather. These relatively fast changes in weather, or describing climate change as a change between states of weather is closely related to the most frequent type of illustrated response (49% of illustrations submitted), which depict climate change as changes in weather conditions. While still an important theme in the open-ended interviews, it was not the most frequent response as it was in the illustrations. This is likely because in the illustrated responses, students were not given any feedback as to the correctness of their responses, nor was there any lead into the exercise. However, by the point in the interview that this question was
asked, many more important questions had already been asked, which may have indicated to the
students that the type of climate change that was being asked about was related to more than just
a change in two weather conditions. Questions leading up to this point signalled for discussions
about environmental issues, the greenhouse effect, and climate change.

The third most frequent response related climate change to the four seasons as
experienced in Ontario, Canada. Seven of the 44 respondents (16%) described climate change in
relation to the changing seasons. For example,

*Suburban Student* - “Climate change to me is just weather changing if you go to summer to
winter there’s a huge change, I think that’s climate change.”

Illustrations of the four seasons as a depiction of climate change was the second most
frequent type of illustration submitted (20%). This indicates that in both the illustrated responses
and the open-ended interviews, children use the model of changing seasons (which are quite
drastic changes in weather) to describe their thoughts of climate change. The four seasons are
taught early in public school in Ontario and is also observed in every day life. Children’s lives
revolve around (to a certain degree) these changes in seasons, and the seasons are associated with
school events, cultural and popular holidays, sports, clothing, and lifestyles. While perhaps
expected more in the illustrated responses, the lead into this question in the open ended
interviews (i.e. discussions of environmental issues, climate change, and greenhouse gases) did
not drastically reduce the frequency of responses relating climate change to the four seasons,
since the percentage of illustrations of this type was 20% and the percentage of responses of this
type was 16%. This is similar to one of the cultural models proposed by Kempton (1991, 1997),
whereby adults tend to use seasonal and geographic variations in climate to understand and describe their thoughts on climate change.

The same number of children (seven of 44, or 16%) described climate change as the idea that greenhouse gas concentrations are increasing due to human activity, and that this is resulting in a wide range of impacts, including increased temperatures. There was considerable variation in the range of responses in this category, demonstrating varied knowledge levels. For example,

*Urban Student* - “I think climate change has to do with an imbalance in the long term weather in a certain region, like let say our region is supposed to be very hot, so climate change would be like some man made reason the weather is shifted and the balance is broken, in that certain area.”,

*Urban Student* - “It’s about the change in the weather and like global warming and other things.”

This was also a category of responses shown in the illustrated responses, in which children depicted some aspect of climate change, which could be considered to be in agreement or at least within the same realm of possibility as the scientific consensus. In fact, an equal proportion of students (seven of 44, or 16%) described these ideas of climate change as the proportion of students (14 of 88, or 16%) who illustrated these same ideas in the initial part of the research process. These results ought to be interpreted with caution. While the data were coded into this category, it may not mean that the student has a full and complete scientific grasp of climate change science, as is indicated in the two diverse quotations listed above.
The last category of student responses related climate change to the popular film, “The Day After Tomorrow”. Indeed, this film has had some impact on public perceptions of climate change (Leiserowitz 2004). While only four of 44 students (9%) mentioned this film, its influence might be even more prevalent and should not be underestimated. More than four of those students may have seen the film, yet not mentioned it in the interview. The disastrous and severe images and impacts portrayed by the film depict a highly exaggerated and rapid sequence of events, which may have affected children’s ideas about climate change, though they may not have made explicit reference to the film in the open-ended interview. When asked to expand on what climate change is, one student that did mention the film stated,

*Urban Student* - “I think it might overflow, not overflow Toronto... sorta like... the movie *Day After Tomorrow* sort of like that.”

This film was an early source of popular information of climate change, for this generation of children. Since its debut, climate change has become a highly popularized issue. Sensationalist images are certainly captivating, and while they may be inconsistent with scientific projections about climate change, they do serve to bring these issues to popular discourse.

For students who had little to remark about climate change, the discussion often ended and the next question had to be asked. In some cases, earlier questions were revisited in order to encourage students who might be shy, to volunteer some more ideas and be more comfortable talking about issues that they might not be very familiar. In most cases, students were able to discuss some parts of climate change (for example, where they may have heard of it), but not all
students seemed confident about their responses. Students were asked to discuss their ideas about the causes of climate change. For example, one student responded,

*Rural Student - “Um, fog or pollution, I don’t really know.”*

The differences between the detail of student responses ought to be noted as well. While some students had a very detailed understanding of climate change, others did not. For example, contrast these following two students’ responses:

*Suburban Student - “I’ve heard from like reading in science books and stuff and my parents that the climate is changing because gas is in the air and is creating big problems because the polar bears in the arctic – not sure if it’s the Antarctic I think its arctic- and they cant get to the fish because the ice is melting and that is bad because there is no land and it is all ice so if it melts then everyone over there will die because they will drown. So if the polar bears can’t get to the fish then there is more fish then they kill the fish they eat and so it is like ecosystem problems.”*, and

*Rural Student -“Isn’t that when the weather change?”*

It is difficult to estimate which student responses were the most important. The aim of the open-ended interviews was to attain a general idea of the types of responses and ideas that children had about climate change. While the ranking of responses and their frequencies does give a sense of the prevalence of the ideas among this group of children, it is also important to highlight the overall themes and discuss their roles in the overall results. A more in-depth discussion of this follows in section 4.2.1.6.
4.2.1.3 Children’s Ideas about the Causes of Climate Change

After asking students to explain their thoughts about climate change, they were then asked to discuss their thoughts about its causes. If the student stated earlier that they did not know what climate change was, they were still asked if they had any thoughts about the causes of climate change. Table 6 summarizes children’s ideas about the causes of climate change. While there were 60 occurrences in this table (and 78 interviews were completed) it should not be interpreted that 60 students responded to this question. In fact, some students may have noted more than one cause of climate change, while others either stated that they did not know what the causes were, or “passed” on this question.

Table 6: Students’ Ideas about the causes of Climate Change: Frequency by Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pollution</td>
<td>10</td>
<td>14</td>
<td>10</td>
<td>34</td>
</tr>
<tr>
<td>Natural Causes</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Fires</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Water Pollution</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Acid Rain</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Nuclear Power</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Deforestation</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Cigarettes</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
<td><strong>18</strong></td>
<td><strong>21</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

The most common response, when asked about the causes of climate change, was the blanket term of “pollution”. While this can be considered as correct, (for example, carbon dioxide emissions from transportation sources and coal burning power plants are contributors of
climate change), the responses grouped in this category were all in general reference to pollution and not specifically to the burning of fossil fuels. One student stated, 

Suburban Student - “All the factories and stuff release chemicals into the air, stuff like that and I don’t know people burning plastic if that stuff will do that to.”

In this case, while factories can be a source of greenhouse gas emissions, this statement reveals a lack of understanding of the difference between other types of environmental pollution and those related to climate change. “Pollution” most often referred to emissions from factories, vehicles, and houses, as well as garbage, waste, and littering. In the case of emissions, if students did not make explicit reference to fossil fuel emissions or the type of emissions (i.e. carbon dioxide or methane), then the data were coded in this category as opposed to the more specific category of “fossil fuels”. For example, when asked about what causes climate change, two different students stated, 

Rural Student - “Cars maybe polluting the air and stuff and littering and yeah.”

Suburban Student - “The factories are still going to release a lot of gas with the fuels, then layers will get thicker and we don’t know if the sun is gonna shine any more, so it’s gonna get hotter.”

This cultural model of pollution, as first identified by Kempton (1991) is one that permeates through adult perceptions as well. There is a moral judgement made on “pollution” as being wrong, and in these cases, climate change is somehow wrong as well. It is not to say that cars and factories do not contribute to anthropogenic climate change, but in the cases coded in this subcategory, these students have not articulated an understanding of the relationship between
the point sources, their greenhouse gas emissions, and the effect on global climate change.

Pollution is a very general term used by many in the lay public and by children to describe
negative human influence on the environment, and in the case of vehicle and factory emissions,
pollution is visible to the naked eye in terms of discoloured smoke, and so is easily detectable
Carbon dioxide emissions are actually colourless and odourless, and so most often, when
referring to pollution, students and adults refer to the visible or noxious odours of pollution and
not the greenhouse gas emissions (Kempton 1991, 1997). Other researchers have also identified
children’s tendency to attribute negative environmental impacts with the types of pollution that
they can either see (littering, smoke, exhaust) or smell (foul odours) (Howe et al. 1996). It is
interesting that while this was the most frequently stated cause of climate change in the open-
ended interviews (57% of coded responses), it was the least frequent theme in the children’s
illustrations of climate change (6% of all illustrations). This could be because the illustrations
just asked for ideas about what climate change was, and not necessarily the cause of climate
change.

Littering was also grouped into this theme, as it is certainly a type of pollution, and is
also one that children are taught about at an early age and they have had the opportunity to see
and observe in daily life. Though not specifically coded or analysed in this research project, one
of the early questions in this interview process (meant to familiarize the student with the
interviewer and ease and interview fears or anxieties) was “what kinds of things do you do to
help the environment?”. Many of the students made reference to school yard clean up programs,
in which students (as a class, with their teacher) travel in the school yard or even surrounding
community, to pick up and properly dispose of litter and waste. When asked to expand on the
causes of climate change, one student stated,
Indeed, garbage and littering are associated with negative consequences among children and adults. It is an environmental issue that the public is being constantly “educated” about, and it is also one where individuals have significant personal influence. Recycling and waste reduction can occur at school, at home, at the workplace, and in everyday life. While not one of the original cultural models proposed by Kempton (1991, 1997), its importance among school-aged children in this study and others (Khan and Friedman 1995, Palmer 1995, Rye 1997) indicates that recycling and waste are sometimes connected to understanding climate change. However, “litter” or “garbage” has little to do with anthropogenic climate change. While it is true that landfill emissions are a source of greenhouse gases (Harvey 2000), litter, as reference to garbage outside of a landfill, has little impact on climate change. While this might have been implied in some of the responses, when asked to expand on their ideas, students did not discuss the role of landfills and greenhouse gas emissions as related to climate change.

The second most frequent response (counted only seven times, in comparison to the previous case of pollution, which was counted 34 times) was that climate change is caused by natural factors. These could include references to the mechanics of the earth’s climate system or even astronomical references. One student stated,

*Urban Student - “I think the world is going closer to the sun probably that is why. Or maybe the sun is coming closer. Maybe that's why.”*
Rural Student - “I think it’s natural because the sun is coming in and doing it but I don’t know.”

and

Urban Student - “It depends on like rotation of the earth, and how the sun is reacting.”

These natural causes indicate students’ understandings of how astronomic forces can influence our climate. The responses, however, do not give information that is specific to the scientifically accepted theories of climate change, such as the Milankovitch Theory, which suggests that the earth’s eccentricity, precession, and axial tilt have affected the earth’s climate with different periodicities throughout its history (IPCC 2001). However, the students’ responses do indicate some understanding of factors that affect our climate. In the current climate change discourse, these natural factors are given less importance as the current concern is with human sources of greenhouse gases, which are affecting our climate at rapid and unnatural rates.

The third most frequent response was that the burning of fossil fuels was a cause of climate change. As stated previously, these responses were not grouped with the blanket term of “pollution” as these statements made specific reference to fossil fuels as the source of pollution or greenhouse gas emissions. One student stated that fossil fuels were related to climate change. When asked to expand, the student replied,

“Cause once the fossil fuels burn, it creates a gas that rises in the air that affects the ozone layer which affects the air that creates global warming.” – An Urban Student

In this case, while the connection between greenhouse gases as a cause for ozone layer depletion, and the connection between ozone layer depletion and global warming are both
incorrect, the idea that burning fossil fuels somehow causes global warming is correct and indicates a more detailed understanding (though flawed) of climate change. Another student stated,

*Urban Student* - “Cars, like the emission and stuff like that, coal-burning factories, yeah that stuff.”

The connection to coal is an indicator that this student’s thinking has extended beyond the blanket term of “pollution”. Another student stated,

*Rural Student* - “The nuclear power plants and the coal stuff.”

Here, the student has correctly identified coal (assuming coal burning) as a contributor to climate change, but has identified nuclear power as a source of greenhouse gases, which is inconsistent with the current scientific consensus.

Some of the other, though relatively less frequently stated sources of climate change include: fires, water pollution, acid rain, nuclear power (as stated above), deforestation, and cigarettes. Each of these groupings had a frequency of 5% or lower. Due to the open-ended nature of the interviews and the use of grounded theory, it is important to note that these were the themes that emerged from the interviews and these were the ideas that the students brought forth.

### 4.2.1.4 Impacts of Climate Change

Students were also asked to discuss the impacts of climate change. This was asked by the researcher through a series of questions including, “When or where do you think it might happen? Who might be affected? Will you be affected?” These questions were meant to determine whether students associated climate impacts with particular places, regions, people, or
environments. Students had varied responses to the impacts of climate change. The four most popular responses were that climate change would result in polar ice melting, that it would have a negative impact on animal populations (not including humans), that it would result in increased temperatures, and also result in increased flooding or sea level rise. Table 7 summarizes all of the themes that emerged from students’ ideas about the impacts of climate change.

Table 7: Ideas about the Impacts of Climate Change: Frequency by Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting Ice</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Animals</td>
<td>3</td>
<td>9</td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td>Increased Temperatures</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Flooding</td>
<td>5</td>
<td>3</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Humans</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Natural Disasters</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Both Animals and Humans</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Less Snow</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Food Supply</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Increased Cloud Cover</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Water Supply</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>38</td>
<td>32</td>
<td>93</td>
</tr>
</tbody>
</table>

The most frequent response (18 of 93, or 19%) was that climate change would result in melting ice. For example, when asked about the impacts of climate change, one student stated,

*Rural Student - “Icebergs in the North and South are melting because of Global Warming, it’s getting warm up there.”*
Melting ice in Polar Regions is a major concern in climate change research, as it affects sea levels, animal populations, general ocean circulation, and water quality. In fact, all of these impacts (related to melting ice) were mentioned by some of the students. For example, the melting ice sheets in the Arctic will have a dramatic effect on animal populations. For example, one student stated,

*Suburban Student* - “There was an article in the newspaper and probably in the year 2015 the ice is going to completely melt and it’s either going to be an ice age or a flood.” – A Suburban Student.

Many of the comments about ice melt were also associated with the other high frequency responses. For example, one student mentioned ice melt, increased sea levels, and animal displacement all in one comment.

“It’s making the north and south pole warmer, it’s melting the ice and stuff. All the animals have to go somewhere else.” – A Suburban Student.

The second most frequent responses were both increased temperatures and impacts on animals. Each of these categories was coded with 18% of the responses. The impact on animal life was most often related to the melting ice, as indicated by some of the quotes above. As another example, one student stated,

*Suburban Student* - “[Climate change] heats up the world and sometimes it might cause animals to adapt and sometimes they are not fast enough and they overheat.”

*Urban student* - “Like lots of things are dying from it and like sicknesses and it’s really hot out and some animals can’t adapt that well, so yeah.”
Increased temperatures were also the second most frequently stated impact of climate change. For example,

*Rural Student* - “I think it means a bit that the climate might change drastically over the years, in places where it’s supposed to be cold during winter but it’ll end up being warmer and warmer like global warming.”, and

*Rural Student* - “It’s going to be really hot in like Canada, which is usually not, sometimes.”

Increased temperatures were mentioned, though cooler temperatures were not. References to milder temperatures were made in relation to winter temperatures, implying a warming as opposed to cooling. Closely related to these first three categories of responses was the fourth most frequently stated impact of climate change, increased flooding. Sixteen percent of the responses mentioned flooding or rising sea levels as a possible impact and almost all of these responses were alongside ideas of melting ice. One student stated,

*Urban Student* - “That it’s going to like, start burning stuff, like Antarctica and somewhere else, the ice is going to melt and flood the Earth and stuff like that.”

Some students mentioned flooding or rising sea levels outside of this context. For example,

*Rural Student* - “Well it could cause like a whole bunch of other changes, like floods, and the sea-level could like raise, and flood everywhere.”, and

*Urban Student* - “You’ll get lots of blizzards and snow and in the spring you’ll get lots of, maybe lots of floods and hurricanes.”
The fifth most frequent response detailed impacts to human life or activity. Eleven percent of these responses fell into this category. For example,

*Urban Student* - “Some people in Siberia already died because the really strong temperature this summer it was like minus 50 degrees or something.”,

*Suburban Student* - “I heard that in other places it is getting kind of bad in places that are already warm it is getting warmer. And that is bad for the elderly and young so if you are left out in the sun you could be like not die yet but if it is getting warmer and warmer if it is already 40 degrees out there if it gets 10 degrees more then it is like 50… then it is bad and you die from it.”, and

*Suburban Student* - “So we learned about Inuits and we learned how they live with the cold but if everything melts there, how are they going to live? They don’t know how.”

The sixth most frequent response detailed impacts related to natural disasters and most often, an increased frequency of natural disasters. Seven percent of the responses were related in some way to natural disasters. For example,

*Suburban Student* - “I was talking to my bus driver once I was bored and she said that when the waves hit the coast and they splash up and comes down again making hurricanes. If it gets warmer that is how hurricanes are made when it gets warm.”,

*Suburban Student* - “In other parts of the world, like if all of the tsunamis have anything to do with it.”, and
“Like there's a blackout maybe and then you get hurricanes and tornados and then like all these houses are gone.”

What is most interesting about this 6th category of responses is that while the first five categories have been generally in alignment with the current scientific consensus on the range of impacts of climate change (i.e. melting ice, increased floods, impacts to animals and humans and increased temperatures (IPCC 2001)), this last category is not as scientifically sound. While indeed, natural disasters and climate change are related and are expected to increase with climate change (Mileti 1999) this is most likely going be in the form of increased storm frequency, severity, and also increased drought (Harvey 2000). Certainly, a tsunami (where the source of the disaster is an earthquake) has nothing to do with climate change. In addition, while blackouts are somewhat related to the problems of climate change (overuse of energy sources or poor energy infrastructure), a blackout certainly would not cause a hurricane or tornado to occur. It is clear that the students’ understanding of disasters, their impacts, and their images (i.e. homes being swept away) have, to a certain extent, permeated their ideas of climate-related impacts.

The other coded responses, with frequencies of less than 5% included: impacts to both animals and humans (it should be noted that the responses coded in the previous groupings would have mentioned either impacts on animals or on humans and not both), less snow, impacts to food supply (mentioned without specific reference to animal or human food supplies), increased cloud cover, and impacts on water supplies (again, mentioned without specific reference to animal or human impacts). These categories all indicate the types of ideas that children in this study had regarding the impacts of climate change.
4.2.1.5 Mitigation Options and Strategies

The last portion of the open-ended interviews sought to understand children’s ideas about possible strategies for climate change mitigation. Students were asked to reflect upon not just what they could do to “help” with climate change (the word “mitigation” was avoided to reduce confusion) and also what others could do to help. Furthermore, students were asked to discuss who these “others” were. All of the types of responses given (of 75 coded responses) had frequencies of 5% or greater. Three types of responses all had an equal number (18 of 74, or 24% each) of responses and were also the most frequently stated. These were: to reduce waste, to call for increased support and action from governments, and to increase energy efficiency and use of car pools. Table 8 summarizes these responses and their frequencies. Again, it should be noted that some students may have mentioned more than one mitigation strategy, while others did not answer this last series of questions.

Table 8: Ideas about Climate Change Mitigation Strategies: Frequency by Area

<table>
<thead>
<tr>
<th></th>
<th>Students in Urban Schools</th>
<th>Students in Suburban Schools</th>
<th>Students in Rural Schools</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Waste</td>
<td>5</td>
<td>8</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>Government Action</td>
<td>5</td>
<td>7</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Car Pool and Energy Efficiency</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>Changes in Industry</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Group Efforts</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>Plant Trees</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>21</strong></td>
<td><strong>30</strong></td>
<td><strong>24</strong></td>
<td><strong>75</strong></td>
</tr>
</tbody>
</table>
Waste reduction refers to a host of strategies including waste prevention, increased recycling, litter clean-up, and litter prevention. For example,

*Urban Student* - “Like stop littering and like tell people not to litter and like recycle and stuff.”,

and

*Suburban Student* - “Do our best to put the waste where it should go like recycling should go in our recycling bins. The garbage that we do have we can either put it in a compost where it will decompose better or we can have our waste. I think everyone should probably think first, before they put it away or they toss it out. They put it in a garbage bag and they just let it go away and think they are not going to do anything they are going to take it away.”

These examples indicate the students’ beliefs that waste and garbage are causes of climate change. When asked what can be done to help with climate change, this was one of the most frequent types of responses.

One of the other most frequently stated ideas to mitigate climate change was that government bodies needed to somehow take charge or increase their environmental efforts. Students mentioned a need for government laws, sanctions, or actions to help improve the state of the environment or mitigate climate change. For example,

*Suburban Student* - “Like the prime minister or the political people that control the running of this country so that if we can convince them that climate change is important and that global warming is having a major effect then maybe they will do something to help about it.”, and
Urban Student - “I think the government, should be really on top of stuff like this and also our teachers should be educating us. Because unlike me and other my friends, a lot of families don’t know about it, if it can’t be at home it should start at school as well.”

In these examples, the students were not clear about what types of actions ought to take place, but were sure that political figures ought to be doing something about it. Also teachers were mentioned as important actors in climate change mitigation efforts. Other students stressed the need for governments to have stronger laws or clearer guidelines for waste reduction and recycling, thus reinforcing the ideas that these initiatives constitute appropriate climate change mitigation strategies. For example,

Rural Student - “The president, well, and the government and all those people... I don’t know, about setting laws or something—don’t litter, but they’ll still do it anyways but they can help and give money or something for people to like clean up and stuff like that.”

These responses recognize the need for government action, as well as assume a need for others to be responsible for action. They suggest an understanding (though sometimes misinformed) that climate change is not a local issue, but a global one, that reaches beyond the children’s immediate communities and surroundings.

Energy efficiency was also stated as a way to mitigate climate change, with the same frequency of responses as waste reduction and the need for government action. For example,

Urban Student - “Not litter, take TTC instead of driving cars [because] it creates pollution if you drive in a car and everyone is in one bus”,
Suburban Student - “Well you know those green cars it would be hard to we could try to get the government to maybe lower the prices for them that way more people would buy them and there wouldn’t be much gases going in the air and maybe when I get old enough to drive and instead of driving I would walk or get a bike that goes fast that way I don’t have to use the car that much and only use it when I have to go long distances like... so that way you’re lessening the gas going into the air”, and

Rural Student - “Uh get a car that runs on solar energy, energy-efficient light bulbs and all that.”

These types of responses indicate an awareness of energy efficiency as a method for mitigating climate change. Fossil fuels were not the most frequently listed source of climate change. Rather, “pollution” was stated most often as a cause of climate change. From this, it is evident that this blanket term of pollution refers to environmental waste and littering, as well as vehicle emissions and other industrial and energy source emissions. It is not always clear, however, if the students were able to differentiate between these types of environmental pollution and their different causes and effects.

The fourth type of mitigation response referred to a need for industries to change their practises. Nine of 75 responses (12%) were coded into this category. For example,

Rural Student - “We can like, the whole people, as a mass, can help try and encourage bigger industries to use less pollutants and stuff and toxins.”;

Suburban Student - “I think all the people that own factories and stuff should try to stop it. They’re the ones who have done a lot of the damage.”, and
Suburban Student - “I think it has to do with the factories, maybe like using some sort of cleaner to like filter the air as it’s going up through the pipes.”

These types of responses indicate the students’ awareness that climate change (or perhaps just environmental problems in general) is the responsibility of others, and is also an industrial issue. Some responses indicate a sense of blame, for example, “they’re the ones who have done a lot of damage”, while others see industries as a source of pollution and toxins. This sense of “others” as having responsibility, in conjunction with a need for government action or legislation, is concurrent with findings from other researchers that have shown children’s tendency to believe in adults and others as responsible for environmental action and also capable of bringing about change (Andersson & Wallin 2000).

There were some responses, however, that indicated a need for collective action (including the respondent) to mitigate climate change. Seven of the 75 responses (9%) were coded into this category. For example,

Rural Student - “Well we can try to do more about it, we can maybe start like a fundraiser or something to raise money to go towards change or we could just get everybody to clean on a certain day of the week to clean the town or clean around your house or stuff.”

These calls for group or collective action also referred to the need for environmental clubs, charities, and support for environmental laws. They do not include any references to individual actions that could be taken by the respondent. That is, these comments all referred to a need for group efforts, and none of the coded responses addressed individual actions that the respondent themselves might taken on to mitigate the effects of climate change.
The last type of response to mitigation strategies referred to planting trees as an appropriate action. Five of the 75 responses (7%) were coded into this category. For example, one student stated,

*Suburban Student - “Plant trees. Stop being stupid and wasting paper”*

Deforestation was one of the main cultural models, found by Kempton (1991), as being of significant influence on people’s thinking about climate change. It is not surprising, therefore, that children would suggest tree planting. Yet while seven responses referenced tree planting, only one earlier response stated that deforestation was a cause of climate change. It is difficult to discern the reason for this discrepancy. It might be because the children were generally unclear about the appropriate strategies and the causes and effects of climate change, that they volunteered ideas that might help the environment in general, and not specifically climate change.

**4.2.1.6 Summary of Interview Responses**

Figure 14 illustrates the main themes and ideas that came from the student interviews. While difficult to quantify the importance of each type of response (other than to give the frequency and percentage of response types), the overall themes are important to highlight. The themes from the students’ responses were not always stated with certainty. Doubt and confusion were often present in the students’ ideas. Children’s ideas about climate change can be grouped into their ideas about climate change itself, its causes, its impacts, and ways to mitigate climate change.
How children learn about climate change is somewhat unclear for this study group. Climate change is not part of the scientific curriculum in Ontario until the 10\textsuperscript{th} grade. Other studies indicate that even with formal training and teaching, children tend to confuse these issues and are still unclear about the scientific causes and effects of climate change (Boyes et al. 1993, Koulaidis & Christidou 1999, Daniel et al. 2004). Results suggest that the issue of ozone depletion is still confused with the issue of climate change by children. Ozone depletion is not
taught to children as part of the formal curriculum in public school. This thesis indicates that ozone depletion, as a cultural model, has affected both adults’ and children’s way of thinking about climate change.

The results of this study indicate that while without standard education in climate change, many of the students in this sample did have some familiarity with the subject matter, though this was often confused with other environmental issues. It is interesting to note that there were a few fairly accurate ideas about the impacts of climate change and methods to mitigate climate change and to a lesser extent, the causes of climate change. However, the tendency to merge climate change issues with other environmental issues (most notably ozone depletion, waste reduction, and deforestation) gives a sense that overall, the students did not have a firm grasp of the issues of climate change.

Of course, there were also many exceptions to this conclusion. Several students did demonstrate rather sophisticated knowledge of climate change through their interviews and also illustrations. Some examples of these include:

*Urban Student* - “I think climate change has to do with an imbalance in the long term weather in a certain region, like let say our region is supposed to be very hot, so climate change would be like some man made reason the weather is shifted and the balance is broken, in that certain area.”

This student not only has heard of climate change before, but understands the difference between daily changes in weather and the “long term” timescale of climate change and regional differences that might occur.
Suburban Student - “I’ve heard from like reading in science books and stuff and my parents that the climate is changing because gas is in the air and is creating big problems because the polar bears in the arctic. Not sure if it’s the Antarctic, I think its Arctic, and they can’t get to the fish because the ice is melting and that is bad because there is no land and it is all ice so if it melts then everyone over there will die because they will drown. So if the polar bears can’t get to the fish then there is more fish then they kill the fish they eat and so it is like ecosystem problems.”

This student has heard of or learned about the plight of arctic wildlife and the effects of decreased ice cover and its effect on hunting patterns, food availability, and hunting season (IPCC 2001). Imbedded in this statement are a several important issues, including the climatic warming itself, the lack of ice cover (referenced here as “land”), food availability, and again a reference to imbalance in the ecosystem. While ecosystems certainly can have multiple steady states of balance, the current state that this student is referring to is in jeopardy due to climate change.

Rural Student - “Like it can happen if umm, okay there’s something like a current, like the Eastern or British or something current and if that changes, then it can affect the climate of the whole earth.”

This student has heard of the changes that might occur to ocean circulation due to climate change. It is not clear, from this brief quotation, if the student is aware of how the currents might end up being affected by changes in salinity due to the melting of polar ice and rising sea levels (Harvey 2000) and it is also not clear if the student understands how oceanic circulation might
have effects on global climates. Nonetheless, this is a fairly sophisticated commentary on one of the many aspects of climate change that scientists are currently concerned with.

Some students did have a relatively sophisticated knowledge of climate change. Because this subject is not formally part of their school curriculum, it can be assumed that the students’ knowledge will be diverse and depend on their teacher’s interest in the subject matter, their parents’ knowledge and interest in the subject matter, and also on the types of films and media outlets that the students watch or pay attention to.

There was a general disconnect between the children’s ideas about the definitions, causes, and effects of climate change. While the students tended to have rather in-depth knowledge of the effects of climate change and mitigation options, their ideas about what climate change was as well as the causes of climate change were relatively less clear. Still though, there was some confusion in all of the types of responses. For example, while children stated that reduction of fossil fuel consumption and increased car pooling was the most important way to mitigate climate change, an equally frequent response was the increased use of recycling and decrease of garbage. This forces an examination of how the environment and environmental issues are represented to children. Climate change knowledge seems to be heavily influenced by media (Leiserowitz 2004).

It can also be concluded that children’s perceptions of risk to self are lower than their perceptions of risk to others. The most frequently stated impacts of climate change referred to places in polar regions or to animal populations. While impacts to humans were mentioned in 11% of the coded responses, most of these responses referred to the general human population and not impacts to the student as an individual. For example one student stated,
Urban Student - “If we stop polluting the Earth it will continue to look like this but if we don’t stop like all the coal-burning factories the Earth will come back to that and we’ll start dying off.”

While another stated,

Suburban Student - “I heard that in other places it is getting kind of bad in places that are already warm it is getting warmer. And that is bad for the elderly and young so if you are left out in the sun you could be like not die yet but if it is getting warmer and warmer if it is already 40 degrees out there if it gets 10 degrees more then it is like 50… then it is bad and you die from it.”

There were no references to personal risk, nor were there any mentions of immediate concern or panic. Climate change impacts, while they certainly have perceived severe impacts to other areas of the world, are not perceived to be of personal risk to these students. Again, this could be partly because there seems to be little immediate environmental attachment to climate change issues. Unlike wilderness perceptions (Lutz et al. 1999), climate change seems to have less of a physical impact on these children’s environmental ideas. There is not a physical attachment of visual experience of climate change as there might be with other environmental perceptions. This is probably why this sample of children did not state a particular concern about how climate change might influence them as individuals. Still though, their concern for climate change issues in other areas or to other animals and humans indicate a concern for these issues.

Other researchers have highlighted children’s concern for environmental issues (Chawla 1988, Bogner & Wiseman 1997, Kellert 2002, Chawla 2002a). Theories of the special relationships of children with nature or their unique perceptions of environment are of interest
not just because of their difference from adult perceptions but also because of the potential for these perceptions to be fostered into life-long appreciations into their adult lives. Climate change might also be an issue that, if communicated effectively and encouraged at younger ages, might be better mitigated by adults who have learned about and cared about the issue as younger children.

This research contributes to the literature that examines adults’ perceptions of climate change by indicating new and emergent themes about climate change, that were not evident before, such as the importance of new cultural models and an imbalanced knowledge of mitigation measures, in comparison to climate change causes and effects. More importantly, this research contributes to literature that examines children’s perceptions of climate change, by widening the range of responses and ideas of climate change, through the use of qualitative research methods. As opposed to using closed form questionnaires, this study used open-ended research methods to assess children’s ideas about climate change. It is not just their ideas about the greenhouse effect or the ozone layer as being related to causes of climate change (Bogner and Wiseman 1997, Koulaidis & Christidou 1999, Daniels et al. 2004), but that there are other issues that are intermingled with climate change knowledge, which are confounding the connections between causes, effects, and mitigation options. Some of these are much more fundamental than a misunderstanding of the greenhouse effect or the role of carbon in climate change, but are concerned with temporal and spatial variations in climate as well as the climate system as a whole.
4.3 Place and Students’ Ideas about Climate Change

This section of the thesis examines differences between the types of responses given in the illustrations and interview data, to determine if any difference exist between the urban, rural, and suburban children. As stated earlier, chi square tests were conducted on groups of illustrations and for interview questions with expected frequencies greater than 5.0. Table 9 summarizes the probabilities of differences between school areas for the illustrated responses with average expected frequencies greater than 5. Table 10 summarizes the results of the chi square tests for all interview questions and responses with average expected frequencies greater than 5. The total sample number for each question varied, due to the fact that some students who may have opted not to answer a certain question, or may have given multiple responses to the same question.

The results describe the probabilities that the observed difference are caused by random variation. Therefore, probabilities of 0.05 or less indicate a statistically significant difference at the 95% level of confidence or greater and probabilities of 0.10 or less indicate a statistically significant difference at the 90% level of confidence.

Table 9: P-Values for Differences between Urban, Rural, and Suburban Students’ Illustrated Responses to “What does Climate Change mean to you?”

<table>
<thead>
<tr>
<th>Type of Illustration</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Four Seasons</td>
<td>0.695</td>
</tr>
<tr>
<td>Weather changes or changes in two weather conditions</td>
<td>0.484</td>
</tr>
</tbody>
</table>
Table 10: P-Values for Differences between Urban, Rural, and Suburban Students’ Responses to Open-Ended Interviews

<table>
<thead>
<tr>
<th>Response</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsure of what “The Greenhouse Effect” is</td>
<td>0.171</td>
</tr>
<tr>
<td>Have not heard of climate change</td>
<td>0.348</td>
</tr>
<tr>
<td>Have heard of climate change</td>
<td>0.703</td>
</tr>
<tr>
<td>Climate change is caused by “pollution”</td>
<td>0.364</td>
</tr>
<tr>
<td>Climate change will impact melting ice</td>
<td>0.947</td>
</tr>
<tr>
<td>Climate change will impact animal life</td>
<td>0.456</td>
</tr>
<tr>
<td>Climate change will result in increased temperatures</td>
<td>0.961</td>
</tr>
<tr>
<td>To mitigate climate change, we ought to reduce waste and recycle</td>
<td>0.910</td>
</tr>
<tr>
<td>To mitigate climate change, governments ought to take more action</td>
<td>0.992</td>
</tr>
<tr>
<td>To mitigate climate change, we ought to carpool more and be more energy efficient</td>
<td>0.792</td>
</tr>
</tbody>
</table>

These results indicate that there were no significant differences between groups for any of the interview questions or illustration themes, at the 95% or 90% level of confidence (P-values of less than 0.05 or 0.10, respectively). Therefore, any variation between these groups is due to random variability and chance.

It can also be assumed that any variation between students is due to factors other than their school district. Researchers seem to be divided regarding the effects of place on environmental attitudes and ideas. While some studies have shown that there are significant differences between urban and rural residents and their environmental perceptions (Lutze et al. 1999, Yilmaz et al. 2004) others have suggested that place does not play a significant role (Bogner & Wiseman 1997, Williams & Cary 2002, Kaplowitz & Kerr 2003). The lived and experienced environment can drastically affect how individuals perceive nature and environmental issues.
Climate change might be an environmental issue that is separate or removed from the lived environmental experience, which children tend to relate to on a daily basis through their play and explorations of their world. Indeed, climate change is an abstract concept that adults also have difficulty relating to in ways other than through existing cultural models, which can blur or misconstrue their ability to understand the causes and effects of climate change (Kempton 1997). Climate change is not a “thing”, which one might be able to see or touch, and because “weather” is observed every day, climate change is further confused with other environmental issues and daily changes in weather. Furthermore, the most dramatic changes that are expected due to climate change are yet to occur in the future, and many of the sources of lay-knowledge about climate change (school, media, government, literature) are not place-specific. Climate change is not experienced daily to the same extent that environmental pollution (for example, poor air quality) or exposure to wilderness (for example, proximity to a national park or wilderness area) are. Its abstract nature has made it more of a learned than a lived experience. A child’s place of residence, either in an urban, a rural, or a suburban environment, has little or no impact on that child’s ideas about climate change. In reference to the conceptual framework illustrated in Figure 4, it is clear then that the physical and built environment (when defined as urban, rural, or suburban areas) does not have a cultural influence on children’s ideas of climate change.

Children must be receiving their information about climate change from other sources, such as films, news reports, popular culture, their parents, or teachers who opt to incorporate climate change into other areas of the school curriculum. This conclusion leaves room for public
education efforts to teach children about climate change, to dispel any common misunderstandings or confusions. While it is now incorporated into the 10th grade science curriculum, students are required to know about the impacts of climate change but not about the underlying science of climate change. Because climate change is not learned in students’ lived environments, it should be taught in other ways, though the current curriculum does not leave much room for climate change education.

4.5 Qualitative Methods to Assess Children’s Ideas about Climate Change

Two main approaches were used in this study. Both open-ended interviews and illustrated responses were able to elicit different and also complementary ideas from children about their views of climate change. While the illustrated responses provided a simple “snapshot” of the children’s perceptions with little or no feedback or encouragement from the researcher, the open-ended interviews allowed the interviewer to expand upon questions and have more of an open dialogue with the children. Closed-form questionnaires have been used in other children’s climate change perception studies by other researchers (Boyes, Chuchran & Stanisstreet 1993, Lesson et al. 1997, Daniel et al. 2004) and other more general studies of children’s environmental perceptions (Batterham et al. 1996, Bogner & Wiseman 1997, Yilmaz et al. 2004). Other researchers tend to favour open-ended and qualitative techniques for

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2 Global warming appears in the Ontario School Curriculum once only, in 10th grade science, under the stream of “Earth and Space Systems: Weather Dynamics”. The learning expectation is that students will, “explain the role of weather dynamics in environmental phenomena and consider the consequences to humans of changes in weather (e.g., the role of weather in air pollution, acid rain, global warming, and smog; the fact that smog aggravates asthma) (Government of Ontario 2007). This learning outcome is unclear, and it appears as though the outcome itself confuses the temporal variations between global warming and weather changes. This misunderstanding is worthy of further analysis and inquiry, as there are no specific scientific learning outcomes anywhere in the curriculum related to the science of climate change.

While most children responded well to the one-on-one interviews, a handful of respondents still seemed quite shy and only gave short answers to each question. Some of the children were also obviously looking for any kind of reassurance of a correct response from the researcher. The children often sought for expressions in from the researcher after giving a response, or even asking for reassurance. For example,

*Rural Student – “...well that’s what I think, anyways. Is that a good answer?”*

*Researcher - “Any answer you give is a good answer, I’m looking to find out your ideas and opinions.”*

*Rural Student – “Ok, but is it the right answer?”*

*Researcher – “Sure it is, if you think so.”*

The open ended nature of the interviews, while allowing for the students’ own ideas to come forward, without the structure of a closed questionnaire, also placed students in a situation of looking for feedback and reassurance. None of the children opted to withdraw from the study (though they were repeatedly reminded that they were allowed to) and also none of the parents or teachers expressed any concern to the researcher either before or after the interviews had taken place. The results of the NVivo7 coding and grounded theory-approach to data analysis revealed several common themes and recurring ideas among the responses. Data analysis was completed after all of the interviews had taken place, to avoid influencing the interviews themselves with the emergent themes.
Given that the range of answers was unknown and no previous studies had examined the influence of place on children’s general ideas about climate change, it is clear that the open-ended interview technique was the most suitable methodology. Furthermore, to add to the exploratory nature of this research and reduce researcher bias, the illustrated responses were used to gain an understanding of the children’s initial ideas about climate change. This research shows that illustrations of mental images can also be extended to more abstract notions of “environment”, including less tangible concepts such as climate change. Brown et al. (1995) utilized illustrations to assess children’s perceptions of nuclear – related risks. However, this concept was still more related to a physical place (a specific nuclear power station). Climate change is a much less concrete concept, especially as it was phrased in this research project. No physical cue or attention to a particular space was given. However, all of the respondents were able to provide an illustration of their cognitive image of “climate change”. Each of these images was coded into one of five categories, indicating little variation in responses. This indicates that among this sample of children, the cognitive images of climate change are fairly similar, with most of the images relating to weather changes, and seasonal changes. Therefore, this group of children did have some definite mental images of climate change, though these images may not have been correct. The misunderstandings of climate change are depicted through these illustrations of seasonal change and weather changes. While it is true that these children might have more in-depth understandings of climate change, as it is accepted by the scientific community, their initial cognitive images reveal a great misunderstanding of the term.

There were slightly more responses from the children’s illustrations than from the open-ended interviews. Eighty-eight children submitted illustration, while 78 chose to volunteer for an interview. This indicates that the illustrated responses were a more appealing methodology
for some children, than the interviews. The children were made aware, ahead of time, of the time commitments required for both, and were allowed to volunteer for one, for both, or for neither. As a qualitative method, illustrations are useful for children not just because they reveal a different type of “snapshot” of the child’s mental images of a particular subject, but also because they require relatively less time than an open-ended interview. Furthermore, the open-ended interview requires that the child interact with an unfamiliar adult, often in a new or different space, which can take them away from their more familiar surroundings (for example in a resource room as opposed to a classroom). These may make the interviews less appealing for some children.

In summary, both methodologies were useful and also complementary in this study. The children and classroom teachers responded positively to both techniques. The illustrations revealed some different ideas of climate change than was gained from the interviews.

4.5 Relevance of Results for an Educational Framework for Elementary Climate Change Curriculum

This study indicates that children have varied understandings of climate change. In general, their familiarity is highest with climate change mitigation strategies, and lowest with the causes of climate change. Figure 15 illustrates this understanding, with the size in area of each aspect of climate change conceptually representative with the level of familiarity that children demonstrated in this study.
The illustrations and interviews revealed new themes in children’s ideas about climate change, which were not prevalent in adult perceptions of climate change, as found in the literature. These new themes (i.e. cultural models) included emphasis on the four seasons, relatively rapid changes in weather and an imbalance among cause-effect-mitigation knowledge. These differences indicate that an educational framework ought to address these differences between children and adult perceptions, and also the relative lack of knowledge of climate change causes and effects, in comparison to mitigation measures. This thesis suggests that a new “Cause-Effect-Mitigation” (CEM) framework (illustrated in Figure 16) might be used, to balance the knowledge of each of these stages in climate change science so that children are equally knowledgeable of the causes, effects, and mitigation measures. Children in this study exhibited a
large breadth of knowledge of climate change mitigation strategies, some of which were consistent with the current scientific consensus (such as reduced energy consumption) while others were not (such as decreased littering). The children’s lesser familiarity with the effects of climate change and even less familiarity with the causes of climate change indicates that their knowledge of climate change is inconsistent with the current scientific consensus. The children’s knowledge of mitigation strategies might be more consistent with “good” environmental behaviour in general, and not exactly specific to climate change. The lower familiarity with climate change causes and effects suggests that their knowledge of mitigation strategies, though somewhat related to climate change, are more likely related to knowledge of general environmental stewardship. A more CEM framework would emphasize each aspect, and also would do so in that particular order.

Figure 16 – A CEM Framework for Climate Change Education
This CEM framework also needs to take into account children’s ideas and perceptions. This is consistent with the best practises from the risk communication literature (Fischoff 1997; Frewer 2004; Heath 2006). By listening to the children’s ideas and concerns, a more suitable risk communication strategy (in this case, a climate change education framework) can be developed. The children in this study used many of the same cultural models as adults to understand climate change, such as littering, pollution, and ozone depletion, and also some cultural models that were new such as abrupt weather changes and seasonal variations. These cultural models need to be addressed and clarified, in parallel with the three stages of the CEM framework, so that students can learn about the relevance of these cultural models to climate change.

For example, one of the most frequently used cultural models of climate change in children (and adults) is the concept of littering, and its negative impact on climate change. Not only should a CEM framework teach children about the causes of climate change, but also explicitly state that “litter” has very little impact on GHG concentrations, and therefore no significant impact on climate change. Of course, children should be taught to not litter and to respect the environment, but in teaching children about the root causes of climate change and also speaking explicitly to this cultural model, a clearer understanding of the causes of climate change can be achieved. Similarly, seasonal changes ought to be addressed in both the “causes” and “effects” stages of the CEM framework. This ought to illustrate the role of the earth’s rotation in natural climate change, the types of seasonal changes that arise from changes in the earth’s rotation around the sun, and the differences between natural and seasonal climate variability versus anthropogenic and longer-term climate changes.
Andersson and Wallin (2000) suggest that children tend to hold on to pre-existing ideas following one-time lessons or short educational units. However, Ronan (2001) suggests that educational units that span longer time frames are more effective than those that are presented as shorter or single units. The CEM framework, due to its complexity and the complexity of issues associate with climate change, ought to span a student’s entire science education. Since children are currently taught about weather and climate in the 5th grade in Ontario, it would be appropriate to begin teaching children about climate change at this age. This framework would first be composed of clarifying students’ understandings of the causes of climate change. The causes of anthropogenic climate change need to be taught in an introductory way that emphasizes the role of GHGs and their impact on regulating the climate of the earth. For example in the fifth grade, an introduction to the concept of a “blanket” of gases to insulate the earth might be an appropriate starting point for climate change education.

The children’s responses indicate that linkages between carbon and climate change are not as clear as they could be. Meijnders et al. (2001) suggest that this link with fossil fuels is integral to climate change risk communication. The “causes” and “mitigation” stages of climate change education ought to address the role of carbon and ways to reduce the use of fossil fuels. Furthermore, education on the causes of climate change ought to emphasize the role of humans and their impact on GHG concentrations and how these concentrations have changed over time. Temporal scales need to address current cultural models of relatively rapid changes in climate, seasonal variations in climate, and the long-term changes in climate that have occurred naturally over time and also are expected to occur in the future due to anthropogenic causes.

The effects portion of the CEM framework ought to draw from the data collected in this thesis. As Frewer (2004) and Heath (2006) suggest, listening to the values of the public (and in
this case of the children) is integral to knowing how to best communicate with them. The children in this study indicated that animals, ice, and natural habitats, as concepts, have resonated in their environmental understanding. These current and established ideas ought to be drawn upon in the CEM framework. For example, the effect of climate changes on polar habitats is a concept that has familiarity for many of the students in this study. Building upon polar animals and their loss of habitat may be a strong starting point for education on climate change effects. This can be done early on in students’ climate change education. As children mature, other effects ought to be emphasized so that students can begin to learn how climate change might make a more immediate or personal effect on their lives. Changes to disease patterns, water availability and quality, unpredictable weather conditions, and air quality are all effects that ought to be taught in this CEM framework. These concepts can be taught over a long time frame, spanning from elementary to secondary school. In fact, if climate change is really to become one of the most important issues of the 21st century, it can be envisioned that climate change education would span beyond a simple CEM framework and weave its way into other disciplines such as geography, political science, economics, and history education.
5. Conclusion and Recommendations

5.1 Main Research Questions

This thesis sought to answer four main research questions, through the use of qualitative interviews with children, children’s illustrations, and a comparison of that information with literature on adult perceptions of climate change. These questions were:

1. How do children, aged 11-12, perceive climate change and climate-related risks?
2. Do any differences exist among students in rural, urban, and suburban areas of Ontario, Canada?
3. How do these perceptions and ideas differ from those of adults, as found in the literature?
4. Do these perceptions, similarities, and differences signal a need for a new educational framework for climate change education and if so, what might that framework consist of?
5. What are the merits of qualitative research methodologies, in understanding children’s ideas about climate change? Do less traditional methods, such as illustrations, make a new contribution to research methods with children?

This chapter draws out the conclusions of this research, as related to the main research questions.
5.1.1 Children’s Perceptions of Climate Change and Climate Risks

Children in this study, aged 11-12, tend to perceive “climate change”, at first instance, in ways that are not related to anthropogenic climate change. The children’s illustrations, taken as “snapshots” into the mindsets of these students, indicate that the term climate change is most often related to a change in weather conditions or a seasonal change in climate. Those students who did illustrate some elements of climate change all did so with a negative connotation or element of risk to animals or human populations.

The open-ended interviews revealed that children’s initial understandings of climate change are often confused with a range of other environmental issues such as pollution or waste management. They are relatively less informed about the causes of climate change than the effects, but are most informed about mitigation options for climate change. The uncertainty and lack of confidence in many of the students’ responses indicate that this is not an area that the group was generally well informed about, though their in-depth knowledge of some environmental issues signals the potential for more comprehensive knowledge of the subject. While the new Ontario Curriculum places some emphasis on climate change in 10th grade science, these learning outcomes are not clear. The students’ knowledge of some of the key elements of climate change, as well as their understanding of other environmental issues indicates that they are capable of learning about these issues. Since climate change is one of the key environmental issues of our time, and because it has permeated many aspects of government, industry, and private life, then it is one that should be taught with more academic rigour in public schools.
5.1.2 Place and Perception: Differences between Urban, Suburban, and Rural Students’ Perceptions of Climate Change

This study also demonstrated that place, as measured by school district, has no influence on children’s ideas about climate change, suggesting that they do not learn about climate change from first hand experiences, nor is climate change an environmental issue that is affected by urban, rural, or suburban differences. This conclusion is drawn from both the illustrations as well as the open ended interviews. There is some evidence in the literature that place does have a significant impact on environmental perceptions (Lutz et al. 1999, Yilmaz 2004). From this research, it seems that climate change is a different type of environmental issue, one that is abstracted from the daily lived experience and knowledge of climate change and ideas about the risks of climate change are not dependent on a child’s physical surroundings. This suggests that educational efforts from the government and school boards might have a significant influence on children’s understanding of climate issues and climate change science. Since place, as defined in this thesis, does not have a significant effect on climate change perceptions, provincial curricula can then cross over all of these boundaries and address climate change for students in a wide range of areas.

5.1.3 Children’s and Adults’ Ideas about Climate Change

This study revealed that children tend to have certain conceptions of climate change that are similar to those of adults, such as the relationship between climate change and stratospheric ozone depletion, pollution, and waste reduction. They are also concerned with other environmental ideas than adults, including nuclear hazards and endangered species. They also exhibit a melding of other ideas of climate change such as seasonal change and abrupt weather
changes, which are less prevalent amongst adults. This signifies the need to clarify the same misunderstandings of climate change in children as in adults, but also to address these more basic fundamentals of climate change, climate, and weather. Also, this signifies that while some of the cultural models proposed by Kempton (1991) are similar to children and adults (e.g. ozone depletion, pollution, and deforestation), others are different (e.g. seasonal variation versus the change of the four seasons, endangered species, and nuclear power). However, what is similar to both adults and children, is the process of information substitution, whereby the both groups tend to use climate-related information or environmentally-sensitive information to explain and understand climate change.

This is of concern because while reducing garbage being sent to landfills and reducing litter are both environmentally sound practises, they have relatively little impact on climate change mitigation efforts, when compared to increased energy efficiency or reducing major sources of greenhouse gas emissions. If most efforts are concentrated on reducing garbage and littering, less effort is then available to address more significant causes of climate change. The appeal of waste reduction as a mitigation strategy is clearly understood, because it is an action that has an immediately measurable effect (i.e. fewer garbage bags on the curb, more items in the recycling bins, a cleaner yard or street) and it is also one that individuals can do with relative ease and little disruption to normal life, as opposed to reducing energy use or changing methods of transportation.

This is inconsistent with the main mitigation strategies, proposed by the scientific community. Waste reduction and recycling have little to do with climate change, when compared to other problems such as carbon dioxide or methane emissions (Kempton 1997), however, it is one that is often associated with climate change by the general public. While it is
true that landfills are a source of methane emissions, it is misleading to assume that waste
reduction is the best strategy for climate change mitigation. It is not to say that it is not a
worthwhile effort in environmental stewardship and sustainable development, however, when
efforts are concentrated in this area, energy is taken away from more direct methods to mitigate
climate change.

5.1.4 A CEM Framework for Climate Change Education

This thesis suggests the use of a CEM framework for climate change education, that
emphasises, equally, the causes, effects, and mitigation strategies of anthropogenic climate
change. The students in this study demonstrated such a relatively high level of familiarity of
mitigation strategies that were both consistent and inconsistent with scientific knowledge and so
this is an indication of the risk communication “vacuum” as presented by Fischoff (1997). The
climate change understanding “vacuum” mirrors students of adults and indicates that this risk
“vacuum” is being filled with other misinformation and influenced by similar cultural models, as
proposed by Kempton (1997) as well as some cultural models that are unique to children. As
Fischoff (1997) suggests, effective risk communication is more than the one-way dialogue from
risk assessors to the general public. Grima (1989) and Fischoff (1997) both purport that people’s
perceptions, ideas and values are important to risk communication. Frewer (2004) also purports
that public perceptions of risk ought to be one of the most important steps when seeking to foster
effective risk communication. Understanding the public’s (and in the case of this thesis,
children’s) perceptions of a risk can help inform other stakeholders (and in the case of this thesis,
educators) of the values that the public holds, what is important to them, what are the areas of
uncertainty and how to move forward in a risk communication strategy. Heath (2006) also
reinforces the importance of listening to all concerns in best practices of risk communication.
This study served to open the lines of communication by bringing the student’s ideas into the “web” of climate change discourse. By understanding children’s ideas of climate change, more effective risk communication and more specifically in this case, climate change education, can occur.

The CEM Framework presented in Chapter 4 is a response to the findings of this study. The children did not exhibit equal understanding among climate change causes, effects, and mitigation strategies. This framework has developed through listening to the children’s ideas about climate change. Ideally, if this framework were to be implemented, educators would continue to listen to and understand changes in children’s ideas about climate change and future educational models should be developed in adaptation to these changes. Future work ought to build upon this framework and work with students, researchers, and educators to develop an effective model for climate change education that can be integrated into the Ontario curriculum.

5.1.5 Illustrations as a Method of Understanding Children’s Ideas about Climate Change

In an era when climate change has become such a popularized issue by the media, the government, and by the lay public, the results of the illustrated responses indicate that there is still a marked confusion among children regarding what “climate change” is. Bronwen et al. (2004) have demonstrated that children do tend to have some understanding of the issue of climate change as well as the effects and main causes. However, such results are often collected through closed questionnaires. When a range of possible answers exist on the answer form, there is less room for ambiguity and uncertainty. Even in a situation when one of the possible responses on a closed questionnaire is, “I don’t know”, children may be less likely to choose a
response that might indicate a lack of knowledge rather than selecting a response that they “guess” might be correct. Other researchers who have used some interview techniques have also demonstrated that children have a fair understanding of climate related issues, but that there is still much misunderstanding and confusions of issues (Rye 1997; Kouldaidis & Christidou 1999; Andersson & Wallin 2000). In some cases, these interviews can influence children’s responses because the child might be seeking assurance of a “right” answer from the researcher (Flowerdew & Martin 2005). Using more open ended methods such as illustrated responses as ways of asking questions allows students to reply in a more free and unguided manner. This study indicates that many students are still unsure of what “climate change” is as a scientific concept or even as a popular phrase.

To classify only 16% of the illustrations as technically “correct” is disheartening. This is an era when climate change has been so popularized by the media, especially films such as “The Day After Tomorrow”, and “An Inconvenient Truth”. The Gore documentary was released during the time that these students were studied, however, its popularity climaxed following the time period of this study, during the spring of 2007, the time surrounding the Academy Awards.

The consistent disconnect between what the scientific community perceives as climate change and the students’ illustrations of climate change are startling. It is also interesting to note that the main themes of the children’s responses (from the illustrations) were somewhat different than the main cultural models and misconceptions held by adults (Kempton 1997). Furthermore, this research shows that the children’s illustrations place little emphasis on pollution as an image of climate change (five of 88 illustrations focused on this theme), while Kempton (1997) found that this was one of the main models which adults use to understand and discuss climate change. Bronwen et al. (2004) used closed form questionnaires to elicit children’s attitudes of climate
change. In such survey instruments, a range of possible answers is given to the respondent, and they can then select the desired response. Asking for an illustration provides almost no further guidance for the respondent. Even in an open ended interview, the researcher can give (consciously or unconsciously) feedback to the respondent, who can then modify or elaborate on an answer. Follow up questions can also be used to clarify ambiguous responses. Asking a respondent to provide an illustration with no other feedback or information asks for a snapshot into the mental map or image of a particular concept.

Mental maps have been recognized in geography as important ways of understanding how individuals perceive their surroundings and important places in their lives (Gould & White 1986). Researchers have suggested using mapping techniques as methods of collecting physical representations of mental maps, especially in children (Alerby 2000). These mental maps seek to illustrate for researchers, a glimpse into the spatial cognition of the research subjects. Visual methods to collect information regarding children’s geographical ideas and images are often used to depict a sense of space or place. Panelli and Robertson (2006) indicate the importance of these images as ways of collecting multi-dimensional and complex information from children, for whom verbal or written articulation might be less effective.

This thesis demonstrated the utility of illustrations as a qualitative research method in studies of children’s ideas about climate change (and most likely a host of other environmental issues). The response rate was slightly higher for the illustrations than the interviews, signalling that this type of research method is more appealing to the children. The themes that emerged from the illustrations were also different than the themes from the interviews. The high frequency of responses of the four seasons and weather changes were less prevalent in the interview data. The illustrations provide a “snapshot” into each child’s mental image of climate
change, with relatively less influence from the researcher than the open-ended, conversational-style interviews.

5.2 Suggestions for Further Research

This research has demonstrated the importance of future studies in this area. The most important next steps ought to address where children are obtaining their information and ideas. Content analysis of popular media, as well as surveys of classroom instruction would be able to assess the sources of the children’s climate change information, as well as asking the children where they gain their climate change (and general environmental) information. The validity of these sources of information, their methods of communication and their effectiveness need to be evaluated.

In addition, studies ought to seek a better understanding of why current cultural models tend to overpower new scientific information and continue to confuse issues of climate change. These cultural models of ozone depletion, deforestation, and littering have permeated climate change discourse. Although these are important to environmental sustainability, these cultural models mask the underlying causes of effects of climate change. Therefore, efforts to mitigate climate change might be misguided and inefficient (for example, focusing on cleaning up parks and recycling as opposed to increasing energy efficiency). Future research needs to address the misunderstandings themselves, to understand why certain misconceptions are so persistent, and to see how they might be clarified. The proposed CEM framework seeks to clarify these cultural models in parallel with climate change education.
This thesis has major implications for educational initiatives, to see where and when children can best learn about climate change and the other important global environmental issues that we are faced with. Climate change is not just an environmental issue, but as stated earlier, it is one that is deeply rooted in issues of equality, fairness, and collectivized action. Further studies and initiatives need to test the CEM framework and its suitability for teaching children about climate change in a way that emphasizes the two important aspects of carbon and the roles of humans within that framework.

Lastly, research ought to examine how children might be better mobilised to not just understand these issues, but to feel empowered that they can have some sort of positive impact on mitigation efforts, which they will hopefully take into their adult lives. By clarifying these issues, the linkages between individual, group, industry, and government actions and responsibilities can be made clearer to the students, so that they can see their roles in environmental issues and better understand how individual action can impact global-scale issues.
Bibliography


Dear Parent or Guardian,

My name is Elise Ho, and I am a PhD student in the Department of Geography at the University of Toronto. I am researching how children perceive environmental and climate change risks. I hope this is going to help generate a better understanding of how children see the environment, and how to better educate them.

The _______________ School Board has reviewed and approved my research project, and has granted me permission to conduct my research in your child’s school.

I am asking you to allow your child participate in my study, under the supervision the classroom teacher. This will last between 45 minutes to 1.5 hours and will all occur during normal class time and on school property. I will ask students to write or draw about their environmental perceptions. Students may also participate in interviews with me.

I will also be talking to the whole class about the environment, and post-secondary education.

This is absolutely confidential. Neither your child’s name nor the name of their school will be published. You are always free to raise questions or concerns, and your child may withdraw at any time.
Please be assured that you are under no obligation to agree to have your child participate in this study. Your child’s participation in this study will have no effect on their curricular assessments or marks.

Thank you for your consideration. Please do not hesitate to contact me with any questions you may have.

Sincerely,

Elise Ho, BSc, BEd, MES
Permission Form for Parents

I, ____________________________________________, consent to have my child ____________________________________________ take part in a study of children’s risk perceptions of climate change and the environment.

I understand that my child will be asked to discuss his or her ideas and views of the environment and climate change during class time, under the supervision of the classroom teacher. I also understand that my child may volunteer to participate in one-on-one interviews during normal school time on school property. My child may also provide the researcher a drawing or a written reflection that will be kept by the researcher, and that is entirely voluntary and will not be used for assessment purposes.

A summary of the findings will be sent to me by my child’s school, and I may request a copy of the thesis in full.
Please return this form to your student’s teacher by: ____________________

Please check one:

I DO [ ] I DO NOT [ ]

agree to have my child participate in one-on-one interviews with the researcher, understanding that any data collected are strictly confidential.

Please check one:

I DO [ ] I DO NOT [ ]

agree to have any submissions created by my child to be retained by the researcher and published (with my child’s name and the name of his or her school removed) in future reports or presentations.

_________________________  __________________________
Signature                  Date

If you have any questions or concerns about this study, please contact:

Principal Investigator
Elise Ho, BSc, BEd, MES

Project Supervisor
Dr. William A. Gough
Assent Script for Illustrations

Read to group of students
Date _________________________

My name is Elise Ho and I’m here from the University of Toronto, gathering information for my school project. I can’t tell you too much about it right now, please remember that I will be coming back to do a talk in your class about the results of my project and to talk more about the things that I research at school.

I would now like to invite you to provide me with a drawing about “What Climate Change means to you”. This is totally voluntary, you can choose to do silent reading instead. If you do decide to provide me with some kind of writing or art piece, please remember that your teacher will not be marking this, and that it is just for my own research. In fact, your teacher won’t even be looking at these. I will keep your work, and may choose to present it in a report or presentation that I might give on my research as an example. But, I will never show your name or the name of your school. Just like everything else, this is voluntary and anonymous.

When you’re done, you can just hand it in at the front and then find a book to read.

Does anyone have any questions?
Thank you for volunteering to be interviewed for my PhD thesis. I’m really glad that you participated in the group discussion, and today in the interview, I’d like us to revisit some of the questions and ideas that came up. This is basically an opportunity for you to talk more about what you think and feel about the things that came up in the group discussion.

Please remember that you don’t have to answer any questions that you don’t want to, and that you may stop participating at any time. Also, please remember that this interview has no effect on your marks, your teacher will not be grading you on this.

Our interview will last about 15 to 25 minutes, and I will be taking notes and tape recording our conversation. Just like the group discussion, the tape and notes are only for myself and my supervisor, no one else will be allowed to read or listen to them. Also, I will never publish your name or your school’s name in any reports that I write about my project, so all of your answers are totally anonymous.

Do you agree to participate in this interview? _____________ (yes or no)

Do you have any questions to ask me before we begin?