Teaching about Climate Change: Making global climate change meaningful to K-8 students

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Abstract

Given the pace of the Earth’s warming, today’s school children are expected to feel its effects more than any previous generation (Plattner, Gian-Kasper, 2013). Education is thought to play a vital role in preparing today’s youth for meeting the challenge (Kegawa & Selby, 2010). This study takes a qualitative look at how a sample of K-8 teachers in Ontario, Canada are creating meaningful and engaging opportunities for students to learn both about the complexity of climate change and about their own agency in responding to it. Two semi-structured interviews were conducted to gather the data which was analyzed and presented in this report. The interviews uncovered that K-8 educators are well positioned to address the multiple dimensions of the phenomenon as they usually teach their students multiple subjects. Secondly, the participants are relating the content to the lives of their students and are encouraging independent thought. As a perceived consequence of their pedagogy, they observed increased engagement and thoughtfulness about the environment the more they learned about it. The study also found that both the physical landscape and school community play a role in supporting teaching about climate change. Finally, the decision to include the topic was made independently by the participants rather than by curriculum mandate. The implications of the findings are then discussed in the context of the existing literature on the topic as well as the educational community. The findings are used to offer some suggestions for the future of climate change education as well as areas for further research.

Key Words: Climate change education, teaching for sustainability, socio-constructivist environmental education
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Chapter 1: Introduction

1.1: Research Context:

There is no longer any disagreement amongst the scientific community that school-age children will experience a warmer climate than their parents’ and grandparents’ generations (Bou-Habib, 2010). Although the extent and character of future climates are unknown, what scientists do agree on is that the consequences of climate change are likely to be severe and that it should be taken seriously by people of all generations (Revesz & Shahabian, 2011).

The area covered by arctic sea ice has decreased from almost 11 million square kilometers in 1900, melting down to about 6 million today (Inter-Governmental Panel on Climate Change, 2013). This has coincided with an average sea-level increase of almost 200 mm. Although 200 mm might not seem like a great deal, it should be considered that the rate at which these processes are happening has significantly accelerated since 1950 (Plattner, Gian-Kasper, 2013). Since 44 percent of people on earth live within 150 meters of the sea, the consequences of this trend could be catastrophic if not kept in check (UN Atlas of the Oceans, 2010). Coastal regions with low altitudes like Bangladesh will be particularly affected (Biermann & Boas, 2010). It is estimated that more than 200 million people (equal to the entire population of Brazil) could become refugees due to the effects of climate change by 2050 (ibid, 2010). The resources and infrastructure needed to resettle this many people would be significant to say the least.

Since scientists can only speculate using climate models as to what will happen in the future, there is a great deal of disagreement over the specific consequences of climate change (Rosenberg, Vedlitz, Cowman & Zahran, 2010). Contrary to several public discourses, human
activities in the form of greenhouse gas emissions are almost universally regarded amongst the scientific community as the main driving force behind the Earth’s warming (Verheggen, Strengers, Cook, et al., 2014). Recent weather trends such as the severe drought in the US’s southwest and massive tropical storms like Hurricane Sandy have not been directly linked to climate change by scientists. Nevertheless, using climate modelling, scientists commonly agree that these types of extreme weather events are likely to increase in frequency and intensity (Meehl, Zwiers, Evans, et al., 2000). In addition, the Intergovernmental Panel on Climate Change (IPCC) has observed the rate at which average temperatures are increasing is also growing. If these trends continue, then we can expect today’s school-age children to be more affected by climate change than the ‘Millennial’ or ‘X’ generations (Plattner, Gian-Kasper, 2013).

Interestingly, although not surprisingly, Dutch researchers have found a correlation between expertise in climate change and agreement on its anthropogenic origins (Verheggen, Strengers, Cook, et al., 2014). Their study suggested that the more a scientist specialized their work around climate science, the more likely they were to conclude that human-induced greenhouse gas emissions are the central force behind global climate change. If this is true, then the implications for climate change education are significant. If more attention is given to learning about climate change as a subject in the classroom, then perhaps popular understanding of the topic might reflect that of the scientific community.

This point is highlighted by another study conducted by the National Research Council who reported in 2008 that 72% of Canadians and Americans believed in human-caused climate change. In 2010, that number had dropped to 50%. The percentage of Canadians and Americans who actively did not believe the Earth was warming in the first place (neither due to human
activities nor natural cycles) nearly doubled from 17% to 36% in the same time span (National Research Council, 2012). The researchers concluded that the variation in public opinion was due a lack of understanding about the topic.

1.2: Research Problem & Purpose

There are about as many sociological dimensions to climate change as there are scientific ones (Gonzalez-Gaudiano & Meira-Cartea, 2010; Hamilton, 2011; Lotz-Sisitka, 2010). Furthermore, many climate models predict such catastrophic consequences for civilization that mitigating its effects can seem futile to many people (National Research Council, 2012). In light of this challenge, the goal of my research is to find ways to teach the complexity of climate change in an effective and empowering way for children. If our future generations are to overcome the challenges of climate change, then they will have to understand what is causing it, how it is happening, who is causing it and how people are being affected. Most importantly, they need to understand that something can be done about it and how.

A major obstacle to students reaching this understanding is that the topic is not explicitly covered by many government-mandated curricula (Sarah, 2010). In Ontario, the Ministry of Education released a document in 2009 making environmental sustainability (including global climate change) an official component of its educational policy (Ontario Ministry of Education, 2009). However, this policy has not yet been implemented as part of the province’s official learning expectations since global climate change are only mentioned as an optional example that teachers could use to meet the specific learning expectations of the science curriculum (Ontario Ministry of Education, 2007).
Furthermore, many teachers express a lack of understanding on their own behalf and do not feel comfortable tackling a subject about which they know little, especially when they are not required to do so (Sarah, 2010). Despite this, opinion polls indicate that children and youth express a great deal of interest in learning about global climate change (War Child, 2006).

1.3: Research Question

The question my research asks is: How is a sample of K-8 teachers creating meaningful and engaging opportunities for students to learn both about the complexity of climate change and about their own agency in responding to it?

Subsidiary questions include:

- How do these teachers integrate multi-disciplinary and cross-curricular dimensions of climate change into their teaching?
- How are these teachers using student-led constructivist inquiry activities for teaching the subject?
- From their perspective, how do their students respond to this instruction? What evidence of learning do they observe?
- What factors and resources support and hinder these teachers’ work?

1.4: Reflexivity Statement

My personal motivation for tackling this topic stems from my knowledge on the subject. I specialized in Globalization, Society and Environment within the geography department at Carleton University for my undergraduate degree. This experience was an intensive, interdisciplinary look at the forces guiding climate change which included everything from
atmospheric science to social movements challenging capitalism. For me, understanding the topic was motivation in of itself to take part in pro-environment demonstrations and advocate for climate change action to politicians.

Given the universal scope and scale of global climate change, I personally cannot think of a single issue more important to humankind today. Although some regions may experience more drastic climate fluctuations than others, no corner of the Earth will remain unaffected by the phenomenon due to the atmosphere’s borderless character. Even the world’s elites who have protected themselves from exposure to hunger, thirst, homelessness and other social strife are not immune to the consequences of a changing climate as previous civilizations have displayed (Diamond, 2005). As the popular scientist, Neil DeGrasse Tyson said jokingly on social media in 2014: “Don’t worry, the earth will survive climate change – we won’t.”

I find it very unlikely that warmer climates will cause humans’ extinction. According to Jared Diamond (2005), there are no known cases whereby climate change wiped out an entire population. Instead, climate change precipitated the disintegration of social cohesion within civilizations. For that reason, I agree with DeGrasse Tyson’s point that ‘we,’ as in global civilization, are unlikely to survive unless we make significant changes on a global scale.

It should be mentioned that I position myself within my research as a person of great privilege, not only as a white male, but also as someone whose livelihood has never depended on the avails from an industry at odds with the pro-environment movement. Growing up in a family of medical workers made it easy for me to embrace the environmentalist message. Alternatively, this may not have been the case if I was raised directly on petroleum or forestry wealth like many other Canadians.
Furthermore, my middle-class upbringing gave me the privilege to focus on my studies and eventually take a Bachelor’s degree in arts. People in different circumstances may have significant barriers to thinking about their carbon footprints. Some people have never been exposed to the concept, while others may focus their thoughts on their day-to-day struggle to make ends meet.

My privilege should also be recognized when conducting my interviews. My race and my gender can influence my interactions with interviewees, especially when they are women, transgendered, or people of colour. I must recognize my privilege in an effort to make my research as anti-oppressive as possible.

My research aims to be consistent with the principles of eco-justice – which holds that people and their environments are intertwined and that caring for one also means caring for the other.

1.5: Overview of the Study

Finding an effective way to negotiate the terrain of teaching children complex ideas, while at the same time not scaring them into complacency, was the end goal of my research. To reach this destination, my primary study consisted of two semi-structured interviews with educators about how they are helping their students learn about climate change. Chapter 2 consists of a review of the academic literature on climate change education whereby I outline the theoretical and practical scholarship on the topic. Chapter 3 includes a detailed explanation of my research methodology. Chapter 4 outlines my findings from my primary research and analyzes them in the context of the scholarly literature. Lastly, chapter 5 is a discussion about what my findings can mean for the educational community as well as myself as an educator.
Chapter 2: Literature Review

2.1: Introduction

There has been a great deal of literature about teaching climate change published in recent years (Gonzalez-Gaudiano & Meira-Cartea, 2010; McGowan, 2013; Sarah, 2010; Sharma, 2012). It is varied, ranging from discussions about society’s conceptual errors in addressing the topic in the classroom, to studies about practical strategies to effectively educate students about climate change (Hestness et al. 2014; Selby & Kegawa, 2010; Matkins & Bell 2007). This literature review is organized into two major sections, each with three subjections. It starts with a discussion about how educators have struggled to help students understand this highly complex and important topic. It then discusses what scholars suggest could be done to address these challenges both theoretically and practically to help students achieve a deep understanding about climate change and how to mitigate its effects. The chapter ends with discussion about what information I find to be lacking within the literature.

2.2: Inadequacies of Traditional Teaching

This section will examine the ways in which the literature suggests traditional teaching approaches have been ineffective at helping students learn about climate change. In this instance, ‘traditional teaching methods’ are comprised of transmission teaching – the students are expected to obtain information through a teacher-led lecture and reproduce their learning through individual activities (Keys & Bryan, 2001). The following section will outline the conceptual, pedagogical and curricular challenges educators have faced in climate change education.

2.2.1: Conceptual Inadequacies
Although the literature about climate change education is quite varied, and sometimes divergent, there does appear to be a near-consensus on one point: the traditional educational paradigm has failed at giving students the tools they need to address the issue (Jamal & Watt, 2011; Gonzalez-Gaudiano & Meira-Cartea, 2010; Sarah, 2010; Lotz-Sisitka, 2010; Reed, 2010; Matkins & Bell, 2007). Some scholars have argued that the traditional approach in education places too much emphasis on taking individual actions in response to climate change rather than learning about structural causes of it (Selby and Kagawa, 2010; Gonzalez-Gaudiano & Meira-Cartea, 2010).

Conceptually, too much attention has been given to actions individuals can take to live sustainably, notably turning off the lights, recycling, taking public transit and eating less meat. This attention has been at the expense of looking at the larger-scale societal dimensions of climate change (Selby & Kagawa, 2010). This type of education reflects a ‘business as usual’ attitude. It overlooks large-scale societal structures that are central causes of problem, particularly free-market global capitalism. This in effect puts the onus of addressing climate change on the individual, as opposed to the political sphere which is paradoxically, the institution most capable of addressing the issue (Selby & Kagawa, 2010).

Lotz-Sisitka (2010) goes a little further in her critique of Western education’s conceptualization of climate change. She argues that we have failed to understand and address global climate change because of our antiquated Westphalian nation-state system. Environmental degradation – especially climate change – does not adhere to national boundaries. With sovereign decision-making authority in the hands of hundreds of nation-states, this poses a nearly insurmountable obstacle to tackling global issues (Lotz-Sisitka, 2010). She argues our education systems are still embedded in this model which induces us to put more emphasis on the national
scale than the global. This manner of thinking is especially problematic when wealth, power and causes of the problem are polarized between the global North and South. This is a concept she calls ‘Climate Injustice’ – whereby climate change is being driven by Western consumption habits. Secondly, the consequences of it are being experienced most by people in the global South who themselves are contributing the least amount of carbon emissions into the atmosphere. Thirdly, rich countries in the global North, who are most capable of mitigating and adapting to climate change, are not compensating poor countries for the effects of their own pollution. Lastly, poor countries are expected to participate in climate change mitigation even though they represent a fraction of its cause (Lotz-Sisitka, 2010). She argues that education systems must re-conceptualize climate change education in order to address the global nature of the phenomenon, and equally as important, the inherent injustice within it.

Another problematic conceptualization of climate change education is the over-emphasis on green technologies and our assumption that they can solve the problem. Sharma, (2012) argues against what she calls “problem-based learning” for two reasons. First, science and engineering are not the same thing – conceptualizing climate change as an engineering problem-to-solve does not necessarily provide students with a deep scientific understanding of the issue. Not fully understanding the science can lead to flawed engineering attempts to ‘solve’ climate change. Secondly, it turns attention away from the deep-seeded socio-political causes of the problem mentioned above (Sharma, 2012).

**2.2.2: Pedagogical Challenges**

Teaching climate change presents an educator with a host of pedagogical challenges, the first of which to be discussed here is the sheer complexity of the topic and the cognitive capacity and
scientific knowledge needed to comprehend it. Gonzalez-Gaudiano & Meira-Cartea (2010) provide a description of this challenge:

If the senses show little capacity to capture the physical signs of climate change, our capacity to select, process, and interpret information is also limited by the principles of economics and simplification in daily life. As a function of these cognitive limitations, the complexity and scale of climate change, in addition to the dimension of uncertainty, establish an important difficulty for its perception and representation by the population (pg. 26).

The sheer nature and scale of climate change is difficult to recreate in most learning environments, which can result in distorted representations of the phenomenon (Gonzalez-Gaudiano & Meira-Cartea, 2010). For example, the common confusion between weather and climate can explain its frequent misrepresentation in popular culture (ibid). Also, the tendency to think that climate change will follow a linear progression fails to acknowledge how unpredictable and unequal the warming of the earth will likely be (ibid).

Research has found that the complex cognitive challenges involved in understanding climate change not only results in a lack of understanding on behalf of students, but amongst teachers as well (Hestness, McDonald, Breslyn, McGinnis, & Mouza, 2014; Gonzalez-Gaudiano & Meira-Cartea, 2010; Sarah, 2010; Matkins & Bell, 2007). In a study amongst Colorado science teachers, for example, 70% of the teacher participants said they felt the need to ‘express both sides’ of the climate ‘debate,’ displaying a lack of understanding about the state of climate science (Sarah, 2010). Similarly, in their survey of US K-12 classroom teachers, Hestness, McDonald, Breslyn, et al. (2014) came to a similar conclusion. They found that teachers were presenting the topic as if it were still a ‘debate’ between scientists as to the causes behind the earth’s warming. The discord between what teachers are imparting in the classroom and the status of climate science mentioned above displays a lack of understanding on behalf of the
teachers which in turn can get conveyed to students, exacerbating misconceptions (Hestness, McDonald, Breslyn, McGinnis, & Mouza, 2014).

2.2.3: Curricular Inadequacies

Another way traditional education has failed to effectively teach climate change can be attributed to inadequate curriculum. Unlike the UK, US and Ontario curricula do not explicitly include climate change as specific learning expectation (Sarah, 2010; Ontario Ministry of Education, 2007). Instead, the decision to cover the topic or not is often left up to the individual teachers themselves (Sarah, 2010). In her study of Colorado science teachers, Sarah (2010) found that 63% of her respondents said they either marginalize the topic by relegating it to an informal discussion or do not address it at all. The most common reason for not including the topic was that there was not enough time to cover material which was not explicitly in the curriculum (Sarah, 2010). This is also the case for Ontario, whereby ‘climate change’ is mentioned only three times within the elementary science curriculum document (Ontario Ministry of Education, 2007). The first two times it is mentioned are italicised examples of possible classroom topics, the third time is a reference to a grade 10 unit (ibid). Never does the topic appear as a unit strand or specific expectation.

Another failure of the current curricular model is what is sometimes referred to as ‘siloing’ – the notion that topics must be taught within the confines of a particular discipline (Hestness, McDonald, Breslyn, McGinnis, & Mouza, 2014; Sharma, 2012; Jabareen, 2011; Sarah, 2010). Given the socio-political dimensions of climate change mentioned above, Sharma, (2012) insists that it must be integrated into the social studies curriculum so that students can develop a deeper understanding of the topic. Jabareen (2011) and Reed (2010) go a bit further by arguing that ecological sustainability is more than a scientific/socio-political issue. Instead it
represents a radical, all-encompassing value system that is necessary to our species’ survival. Therefore sustainability ought to be a lens through which we teach everything from mathematics to physical education (Jabareen, 2011; Reed, 2010). The ‘weaving’ of sustainability into every aspect of the curriculum engenders systems-based thinking – the interconnectedness of all things within an ecosystem. Despite that many of these interconnections are observable and generally understood, Western models of thinking have not traditionally acknowledged them as being fundamental to learning (Reed, 2010).

2.3: Existing Research on Effective Pedagogy for Teaching about Climate Change

The next section outlines some suggestions the literature has made as how to improve upon the short-comings illustrated in the previous section. The three areas to be covered are social constructivism, classroom activism and professional development.

2.3.1: Constructivist Activities for Students

Across the literature there seems to be a consensus on how teaching styles ought to change in order to address the challenges mentioned above. Overwhelmingly, authors on this topic agree that a socio-constructivist inquiry-based approach to teaching should replace teacher-led, textbook-based lessons which fall within the traditional disciplines (McGowan, 2013; Jamal & Watt, 2011; Gonzalez-Gaudiano & Meira-Cartea, 2010; Taber & Taylor, 2009; Langis, Gravel, Bourque & Praneua, 2003).

Constructivist teaching methods are an application of Jean Piaget’s cognition theories developed in the twentieth century which holds that:

Students acquire a fuller understanding if they are personally involved in building their knowledge. It is not enough that teachers go further into a subject, students must go with them; and they will
do so if they are engaged intellectually, emotionally and in other ways (Beck/Kosnik, 2004, pg. 18).

McGowan (2013) illustrates this point in his study of US classrooms. He observed high levels of student engagement with topics which affected the students’ personal lives were discussed, namely Hurricane Sandy. He found that political controversy had a positive effect on student engagement and that the students who struggled in science and math became more likely than before to persist in their studies as a result of introducing the cross-curricular dimensions of this topic (McGowan, 2013).

Taber and Taylor’s (2009) research agrees with McGowan’s in that students enjoyed and learned best from hands-on activities. In their study on effective climate change teaching methods they found a direct relationship between increased understanding of climate change and concern about the issue. However, they expressed caution in that concern for the issue did not necessarily translate into more environmentally sustainable behaviour. Furthermore, they found limited success in changing students’ pre-conceived misconceptions about climate change despite employing the constructivist strategy of addressing and incorporating students’ pre-held ideas into the lesson (Taber & Taylor, 2009). Evidently, constructivist teaching methods are not a silver bullet for teaching complex and controversial topics like climate change.

In order to limit the degree to which students form fallacious understandings about climate change Lee, Ma, Lambert, & Lester (2006) suggest the topic should begin to be taught at the elementary level. They conducted a study on using an inquiry-based instructional method for teaching a grade 5 science unit on climate change and they analyzed students’ writing samples. They found that the number of responses using accurate science from each student as well as the number students providing them increased at the end of the unit. The number of students who displayed an increased understanding more than doubled from 31% before the study and 64% at
the end. Misconceptions, such as the ozone layer playing a role in the greenhouse effect, persisted at the end of the unit. However, they suspect that the assessment tool – a writing sample – may have been flawed given the students’ underdeveloped writing skills (Lee, Ma, Lambert, & Lester, 2006).

An alternative sustainability teaching method has been proposed by Wendy Angew (2010) who incorporates Jabareen’s and Reed’s theory that sustainability education should be integrated into the whole curriculum. She advocates for teaching sustainability through narrative since it is engaging for students of all ages, and more importantly, engenders students’ imaginations, enabling them to think differently (Agnew, 2010). Activities she has used include: doing presentations on alternative energy, research projects on traditional societies with traditional knowledge (activities include dramatizations and mask-making) as well as environmental adaptations of Shakespeare (Midsummer Night’s Dream) (Agnew, 2010). Although the efficacy of Agnew’s teaching methods have not been clinically measured, they do offer an interesting alternative to traditional textbook-based learning.

Though there is a general consensus on the utility of constructivist methods, Lotz-Sisitka (2010) offers a critique of the way in which they are sometimes conducted. She says that some locally-based activities that teachers prepare do not make connections to the global scale. For example, enacting student ideas like turning off the lights and growing a classroom garden does not necessarily address the bigger issue of consumption. Thus, this type of learning may be constructivist and participatory, but not necessarily transformative if it fails to consider the bigger picture (Lotz-Sisitka, 2010). Therefore not making some key connections can fail to achieve climate educations’ main purpose – to effect positive change.

2.3.2: Classroom Activism
Classrooms should not only be spaces for learning about environmental sustainability, they should also be places where students learn to take action to obtain it (Sharma, 2012).

Given that global climate change is primarily a societal issue, the chances of meeting this challenge successfully are far greater if the core impetus for action comes from the people and not the experts. Science education needs to play an important role in making this happen. It should prepare students to play an active role as citizens in making the state as well as the society responsive to the issue in ways that are sustainable and evidence-based (pg. 48).

Sharma’s quote highlights the role that science education can play in effecting change. The classroom needs not only to be a space where children learn about climate change, it also needs to be a place where they learn how to overcome the challenge. Although evidence suggests that constructivist teaching methods have increased students’ belief that they have agency to do something about the problem (Taber & Taylor, 2009), it should not be assumed that understanding will necessarily result in action (Gonzalez-Gaudiano & Meira-Cartea, 2010).

The study by Langis, Gravel, Bourque & Praneua (2003) can shed some positive light on constructivist teaching methods’ ability to promote classroom activism. They conducted their study in Moncton, NB and Montreal, QC whereby students were invited to share their own opinions and ideas about climate change so that they could be opened up to inspection. From the outset, they found there to be a common sentiment that it would be unlikely that society would do anything to address the issue. Using “conceptual change theory” – the process of conceptual development by which students’ initial ideas develop into more scientific notions, they observed not only an increased understanding about the topic but also a sense of empowerment to do something about it (Langis, Gravel, Bourque & Praneua, 2003). This example displays how socio-scientific education can be transformative in both knowledge and outlook.
2.3.3: Teacher Professional Development

Another portion of the literature on climate change education looks at the need for professional development on behalf of teachers (Hestness, McDonald, Breslyn, McGinnis, & Mouza, 2014; Sarah, 2010). The topic cannot be taught in a meaningful way without a sound understanding on the part of those facilitating students’ learning. Calls have been made for professional development programs to address this issue (Hestness, McDonald, Breslyn, McGinnis, & Mouza, 2014; Matkins & Bell, 2007).

Evidence from multiple sources has shown that professional development workshops are effective at reducing misconceptions, deepening understanding, highlighting the topic’s cross-curricular nature and giving teachers a sense of confidence and preparedness in tackling the subject (Hestness et al., 2014; Sarah, 2010). For example, Hestness, et al. (2014) addressed teacher-held misconceptions head-on by surveying their participants’ knowledge on the subject and focusing on the misconceptions which emerged from the surveys. Common misconceptions included a lack of scientific consensus on the causes of global warming and the ozone layer’s role in the greenhouse effect. The researchers then held ‘interventions’ to correct these specific misconceptions held by their teacher participants (ibid).

Matkins and Bell (2007) went a bit further and found that teacher candidates from across the US not only lacked sufficient knowledge about climate change, but also held several misconceptions about science in general. The two held a workshop for teacher candidates whereby the participants learned about climate change as a vehicle for attaining a stronger scientific understanding. The teacher candidates left the workshop with a better understanding in both areas (Matkins & Bell, 2007). These examples go to show that teachers should not feel shame in admitting they do not properly understand something they are supposed to teach.
Instead, these examples display what professional development workshops can do to improve climate change and science education in general.

2.4: What Has Not Been Found in the Research

An important component of my study that mostly eludes the literature is how educators can spur their students into action against the effects of climate change. Much of the literature such as Taber & Taylor (2009) and Langis, Gravel, Bourque, et al. (2003) have looked at student activism, but have not come up with solid evidence to suggest that students care about climate change enough to change their lifestyles in order to mitigate its effects. Further research on this topic would greatly benefit the educational community.

Lastly, much of the research discusses a reconceptualization of climate change teaching (Sharma, 2012; Lotz-Sisitka, 2010; Agnew, 2010). Little of it is focused upon assessing the effectiveness of certain teaching strategies vis a vis how well students learn. Lee, Ma, Lambert, & Lester (2006) looked at this, but as mentioned above, their assessment tool, a writing sample, was inappropriate for assessing the learning of students who struggle at articulating their thoughts in writing.

2.5: Conclusion

The areas in which information is limited within the literature informed the questions of my primary research discussed in chapter 1. Particularly, I am interested in the way educators perceive how students respond to their methods. Do teachers get the impression that students leave their class with a sense of empowerment to address climate change? Or do they leave class with an understanding but a sense of hopelessness that anything will ever change about human behaviour? Where the literature more or less reached a consensus was that teachers ought to use a socio-constructivist, inquiry-based approach to teaching climate change. This gives me a frame
of reference for making meaning of my own data. My own research is intended to inform Canadian teachers about what their peers are doing to not only help students understand global climate change, but how they are encouraging their students to mitigate it. The next chapter outlines the methods I used to do this.

Chapter 3: Research Methodology

3.1: Introduction

In this chapter I review the methodological considerations for my study. Here I reveal my research approach and procedures, the instruments used to collect data, information about the study’s participants, how the data was analyzed, the ethical review procedure, and a consideration regarding the strengths and limitations of my selected methodology.

3.2: Research Approach & Procedures

My study on climate change education consisted of two major parts: A review of the extant literature on the topic (see chapter 2), and a qualitative inquiry research component involving two semi-structured interviews with teachers. Qualitative research is often used by scholars to explain mechanisms or seek meaning behind causal sociological theories or models (Cresswell, 2013,). Thus, a qualitative study best addresses the intended purpose of my study given that I was interested in learning what educators are doing to teach climate change in a way that is meaningful to K-8 students. This is by definition an exploration of meaning – the type of inquiry qualitative research was designed for.

3.3: Instruments of Data Collection
The primary instrument of data collection was a semi-structured interview protocol (Appendix B). Semi-Structured interviews consist of respondents answering pre-set, open-ended questions over the course of about 30 minutes (Jamshad, 2014). This method enables researchers to ask follow-up questions and pursue unexpected ideas which might emerge in the process (Rose, 2013).

Semi-structured interviews were chosen as my data collection device since they can be used to explore meaning and perceptions in order to gain a better understanding of a given phenomenon (DiCiccio-Bloom & Crabtree, 2006). Given that my research focused on the interpretations of educators’ of their teaching practice about climate change employing this instrument of data collection was deemed appropriate.

3.4: Participants

My study’s two participants were chosen according to the emphasis they put upon global climate change in their classroom teaching. They both participated in the research on a voluntary basis. Below is information about my sampling criteria and recruitment methods as well as biographical information about them.

3.4.1: Sampling Criteria

The participants for the primary portion of my research were selected because they fulfilled three criteria. The first criteria was that they have, at least 5 years of classroom teaching experience at the K-8 level. This experience gives my participants perspective on the topic that new teachers would not necessarily possess. This perspective enabled a degree of reflexivity on their behalf regarding their own teaching practices and values, which ultimately provided more rich data for analysis.
Secondly, the educators had all been teaching within the last 12 months. This criterion was necessary to me given global climate change’s pertinence and continually emergent nature. Just about every month there seems to be new information about the topic, and a component of what I was interested in learning from them was how they stay on top of emergent knowledge about climate change.

Finally, given my primary research question, the participants’ teaching style needed to put emphasis on climate change and its multidisciplinary nature. This was not measured as a discrete number of teaching hours dedicated to the topic. Instead, it was whether or not the educator self-identified as teaching about climate change through a cross-disciplinary approach.

### 3.4.2 Sampling Procedures and Recruitment

Participants for this study were found using a convenience sampling procedure. Although convenience sampling is seen as less rigorous compared to other sampling models since it can distort data by representing a narrow cross-section of the population (Marshall, 1996), it does spare the researcher time and money which is necessary for an unfunded Masters research project. Sampling was also purposeful in that I had specific criteria that teachers needed to fulfill.

Specifically, my participants were found using networks available to me through professional communities such as *Green Teacher*, a non-profit promoting sustainability amongst educators. The organization was contacted and asked for recommendations of educators who would be interested in participating. My information was distributed and those interested in participating contacted me.

### 3.4.3 Participant Bios
Camille

At the time of the interview, Camille Potter had been teaching in the Ottawa area for 5 years. At the time of this study she was teaching as a homeroom grade 1 French-Immersion teacher. Having taught core French in previous years for students ranging from grades 1-6, she was glad to have her own classroom, giving her the chance to go deeper into topics she cared about, including environmental sustainability.

Charles

At the time of the interview, Charles Rice had been teaching for 27 years. Charles had taught almost every grade from 1-8 over his career but spent the majority of it teaching grades 7 and 8. At the time of the study he was teaching integrated math and earth sciences to two grade 8 classes at a private school in Toronto.

3.5: Data Analysis

The primary data I collected in the interviews was recorded on a digital recording device and subsequently transcribed into text manually. The transcribed text was then closely examined and coded. The coding process included applying 2-3 word phrases which encapsulated the salient point or meaning behind a given passage of text from the interviews. The codes were then organized into broader categories according to their area of relevance. (i.e. codes relating to teacher practices were categorized as such, ones relating to curriculum fell into a category of that name, etc.) Reviewing the data organized into categories I then attempted to answer my research questions. These responses to my research questions are what emerged as my 5 themes in chapter. This process was aided by eliminating the codes which I deemed to be not relevant to my research questions. Decreasing the number of codes can make it easier for a researcher to
reduce the content discussed in a report to just handful of themes (Cresswell, 2013). Therefore, I decided to condense the volume of codes to make it easier to focus on the ideas related to the purpose of my study.

3.6: Ethical Review Procedures

In order to respect the privacy of the educators who participated in this study, their real names have been replaced with pseudonyms. Both participants signed a letter of consent (Appendix A) which detailed all of their rights as a participant and informed them about how their personal information would be used. It stated that I would not use your name or anything else that might identify them in my written work, oral presentations, or publications. This information remains confidential. They were also assured that the only people who will have access to my assignment work will be my course instructor. They were reminded that they were free to change their mind at any time, and to withdraw even after having consented to participate. They were also told that they could decline from answering any specific questions. Participants were told that I would destroy the audio recording after the paper has been presented and/or published which may take up to five years after the data has been collected. They were also assured that there were no known risks or benefits for assisting in the project.

Beyond consent, there was another ethical matter to consider. My data collection device, the interview, can carry some ethical challenges with regards to the handling of sensitive personal information and the potentially unequal power relationship between interviewer and interviewee (Cresswell, 2013; Potts & Brown, 2005). Therefore it was necessary for me to be reflexive in my role as interviewer with regards to my participants and include them in as much of the process as they felt comfortable with (Potts & Brown, 2005). That is why I tried to
disclose as much information about what the purpose of the interviews was in order to mitigate an unequal power relationship between interviewer and interviewee.

3.7: Methodological Limitations & Strengths

The study’s sample size and sampling method limits the rigour of the research and the extent to which I can speak to what educators are doing to teach climate change in a meaningful way (Marshall, 1996). Three individuals are in no way a representative sample of any population whether on a national, sub-national, or even municipal scale. The scope of my research is limited to the individual pedagogical approaches of the three individuals with whom I sampled by convenience, further limiting the degree to which my participants may represent a wider population. That is to say that no statistical data should be gleaned from this study in any way to represent a wider trend of climate change education in Toronto, Ontario, or any population. The findings are not generalizable to a broader population.

Contrarily, my methodological strengths are found in the experiences of my participants and the meaning they made of them. Each of them having (at least) five years of classroom experience gives them insight into the complexities of climate change education for young learners. Since I have selected interviews as my primary data collection tool, it enabled me to gather data thoroughly and flexibly – ways that rigid surveys or questionnaires could not (DiCiccio-Bloom & Crabtree, 2006). Between the depth of my primary research and the extent of my secondary research, they combine to give a sense of climate change education on both the small and wider scales.

3.8: Conclusion
This research employed a qualitative inquiry method. Doing so allowed me to analyze meanings and explanations behind educators’ pedagogy. Taking a quantitative approach to this study has both its strengths and weaknesses. It makes it possible for me to find some explanation for the way educators are teaching climate change to younger students but in no way enables me to make inferences about climate change education across a wider population. In the next chapter I provide a detailed account of my primary research findings.

Chapter 4: Findings

4.0: Introduction

Through analyzing the data produced by my two in-depth, semi-structured interviews, five themes emerged. First, I found that educators in K-8 classrooms are well-equipped to address the cross-curricular and multi-disciplinary dimensions of global climate change due primarily to the fact that they see the same students for most of the day. Secondly, I found that climate change educators are designing their lessons in ways that reflect the lives of their students and promote original thought. Thirdly, teachers are observing increased thoughtfulness and engagement towards the environment as a result of their teaching. Fourth, the school community plays a significant role in how successful an educator can be. Finally, my participants are making loose connections between their climate change teaching and their mandated curricula. Furthermore, their choice to include it is due to a deep personal conviction.

In this chapter I will elaborate on these findings and relate them to the existing literature on the topic. I will end the chapter by suggesting an area for further research.

4.1 - K-8 teachers are particularly well-positioned to address the cross-curricular and multi-disciplinary dimensions of global climate change
Thanks to their specific roles as K-8 educators, my participants displayed that they are well-situated to address the cross-curricular, multi-disciplinary nature of global climate change. The reason for this is that both of my participants saw their students for several subjects making them more able to weave climate change into multiple subject areas rather than just one, as most rotary teachers typically experience.

As Camille Potter (pseudonym), a grade 1 educator said about teaching climate change as a homeroom teacher: “I can pull everything together and make it so cross-curricular that you can really focus on something, but repurpose it and come back to it later from a different point.” In her case, she would often introduce the concept of sustainability through read-alouds as a part of her literacy program. She would then link the topic touched upon in her books to social studies via a curriculum strand about responsibilities, justifying it by saying that it is our responsibility to steward the planet. This example is on top of the climate change content she links to the science and technology curriculum.

Grade 7 / 8 educator Charles Rice employed a similar approach to Camille, but with older students. He taught science and geography integrated with one another, not as separate courses or time slots. He says that carbon, the main contributor to global climate change ‘underpins’ everything he does in his classroom. For example, he will have his students examine their own daily activities and calculate how much carbon they generate. Upon establishing their personal ecological ‘footprint,’ he then has the students determine how many Earths would be necessary to sustain 7 billion people who lived as they do. These activities involve a great deal of mathematics which Charles has also integrated into his science and geography course.
Camille’s capitalization on her role as a homeroom teacher to discuss the cross-curricular nature of climate change avoids what Sharma (2012) described as ‘siloing’ – an approach to teaching that attempts to compartmentalize each component of a topic or phenomenon within a specific academic discipline. As discussed in Chapters 1 and 2, climate change has many social and scientific dimensions. No one curriculum is equipped to teach students everything they need to know about the topic. This has contributed to the reason why students often develop an incomplete and distorted understanding of it (Sharma, 2012). Camille’s position as a literacy, mathematics, social studies and science teacher has the potential to help her students develop a deeper and fuller understanding of all of climate change’s vast and complex dimensions.

Camille and Charles’s multi-disciplinary approach to climate change education resembles what Reed (2010) described as ‘weaving’ sustainability into teaching, rather than Sharma’s (2012) concept of siloing. We often think of our human existence as separate from nature (Lena & Betanzos, 2011). It is problematic to think this way because all of the materials and energy we use is derived from the global ecosystem (Reed, 2010).

Ecology is literally all-encompassing, and Camille and Charles’s teaching about it reflects this. Camille and Charles’s multi-disciplinary approach is intended to help their students understand that their lives within a built environment are not somehow insulated from the natural world and that ‘human’ and ‘natural’ systems are woven together as tightly and as intricately as their math, science, social studies and literacy units have been.

In addition, Camille’s pedagogy – ‘weaving’ sustainability into the grade 1 curriculum—could have particular implications given what Lee, Ma, Lambert, & Lester (2006) found in their
research. They acknowledge that much of the students’ learning occurs outside of the classroom and that an educators’ ability to control what they learn from TV or films is limited (Lee, Ma, Lambert, & Lester, 2006). That is why they suggested that climate change should be introduced as a topic in grade 5 in order to pre-empt misconceptions as they develop through exposure to oversimplified media representations. However, by grade 5 most students will likely have already been exposed to fallacious notions about climate change through their day-to-day lives. This is what could explain the pervasive misconceptions that persisted at the end of their study, namely climate change being linked to ozone depletion (Lee, Ma, Lambert, & Lester, 2006). By starting in grade 1, Camille’s holistic approach may be able to intervene against these misconceptions since six-year-olds have had far less exposure to fallacious science than eleven-year-olds. Perhaps the problem with Lee, Ma, et al.’s study was not its data collection tools, but that its attempt to intervene against misconceptions was not early enough.

4.2: Climate Change educators are engaging their students by designing lessons in ways that mirror their lived experiences and encourage independent thought.

This study’s participants were finding ways to engage their students in learning about climate change by relating the subject matter to their own lives. This, they believed, made their students care about the subject more since they could see how it affected them directly. Their approach also fosters independent thought by allowing knowledge to be generated by the students themselves as well as leaving space for them to draw their own conclusions about what they have learned.

This is best exemplified by Charles’s ‘ecology of a T-shirt’ activity. In it, students were asked to investigate the environmental impacts of producing something everyone in the room
had several of. They tried to determine how much carbon and other pollution would be involved in growing the cotton needed for the T-shirt, then processing it and shipping it from wherever it was produced. Through this exercise, Charles’s students were able to observe for themselves the environmental impacts of their daily lives.

The key to Charles’s approach, he says, is that he does not ‘preach’ to the students: “I would say reserve our own personal judgments… so that the kids can get there on their own. It’s probably more powerful.” Social constructivist education proponents would agree. By linking climate change to the students’ lived experiences and enabling them to build their own knowledge they deepen their learning (Beck/Kosnik, 2004; Taber & Taylor, 2009).

Camille employs a similar approach in primary. In one of her activities for a group of grade 1’s, 2’s and 3’s, she had them examine tree rings on a bunch of logs. She highlighted how the rings were wider apart in recent years and asked them to think about what that might mean given what they had learned about plant growth. In her words she teaches “…Through a lens where you’re exploring with the kids rather than teaching something at them.”

Charles and Camille’s social constructivist pedagogy may have implications for scholarship on the topic. Scholars decry how sustainability education often places too much emphasis on taking individual actions in response to climate change rather than learning about structural causes of it (Selby & Kagawa, 2010; Gonzalez-Gaudiano & Meira-Cartea, 2010). Since students learn best when they build on their own experiences and generate their own knowledge, then it is possible that allowing them to draw their own conclusions about the big picture could be the key to teaching the importance of structural change. Charles never explicitly indicates the gravity of climate change’s implications for his students’ lives. Instead he leaves it
as “the elephant in the room” for the students to conclude for themselves. Perhaps this way his students will be more inclined to make social change when they generate the idea themselves.

4.3: Teachers are observing enhanced understanding, engagement and thoughtfulness about climate change the more the students learn about the topic.

As discussed above, global climate change is a vastly complex and multi-faceted topic. Consequently, it is difficult to inspire people to care about a topic they vaguely comprehend (Langis, Gravel, Bourque, et al. 2003; Taber & Taylor, 2009; Gonzalez-Gaudiano & Meira-Cartea, 2010). Charles and Camille have both observed that their students engage more with the topic, deepen their understanding and outwardly display thoughtfulness about climate change as they learn more about it.

Charles explained that he frequently got a negative response when he introduced the topic: “Sometimes the outcome is very oversimplified, and very ‘we’re all screwed’, you know.” At this stage, his students’ understanding is rather limited and their thinking about the topic is reduced to defeatism. However, as his course progresses, he begins to “unpack” the complexity of the topic with them.

For example, to help his students comprehend the concept of geological ages he distributed long strips of paper or scale models as manipulatives. “You and I, we take it as a matter of fact, you know the difference between a 20,000 year stretch [and] a hundred year stretch.” By using the manipulatives, students can see a visual representation of time depicted as the length of the strips.

The next stage involved helping his students understand that the earth’s temperature usually fluctuates over the course of a geological age by a couple degrees Celsius and that is the
difference between an ice age and a warm period. In his words: “… Two degrees doesn’t sound very dramatic. Two degrees sounds like, ‘so what.’ Until you kind of unpack the reality that most of life is quite finely tuned, and two degrees or an extra week of frost here, or a little bit of missing ice there is actually a big deal.” It was usually after this unpacking that Charles observed a marked increase in engagement amongst his students.

Charles is overcoming what Gonzalez-Gaudiano & Meira-Cartea (2010) describe as the difficulty educators experience at perceiving and representing climate change. He has found a way to represent large, intangible concepts such as big time using physical objects and relating them to familiar concepts. Charles’s approach may have something to offer Gonzalez-Gaudiano and Meira-Cartea in terms of breaking-down the complexities they discussed and making them more palatable to K-8 students.

Camille has also observed increased engagement over time: “I find that they’re very interested. I find that [progressively], they’re more interested and more invested.” She also explained that she was not alone in this observation, as administrators and other teachers at her school: “… said they noticed that they are a thoughtful group when it comes to those sorts of things.”

For her, this increased engagement stuck with her students beyond the lesson: “The teacher from the environment club said that they were always trying to better the school, outside of their own classroom even.” This is a practical example of Agnew’s (2010) assertion that integrating literacy and ecology engenders imagination and transforms thoughts and ideas. Her work lacked evidence that this style of teaching had the type of effects she described on actual
students. The anecdotal feedback Camille received about her student’s thoughtfulness could be evidence supporting Agnew’s theory.

4.4: A school’s physical and human environment plays a crucial role in supporting or hindering a teacher’s success at climate change education

Both participants indicated that factors outside of the classroom play an important role in their success at teaching about climate change. The factors they highlighted were faculty/administrators, families and the physical landscape surrounding the school. The alignment of these factors can make the difference between success and failure in the classroom.

Camille attributed a significant portion of her success as a climate change educator to the support she felt from other teachers and administrators. She explained that there were a few teachers on staff that are very like-minded. In her experience, this support could take the form of sharing resources such as objects from the outdoors and ideas for various activities.

Charles echoed Camille in feeling supported by his own faculty and administration, which gave him the latitude to take liberties with the curriculum. He explained that his school’s administration allowed him to design his own sustainability course with very limited reference to the Ontario curriculum.

Charles also discussed how families play a role in his teaching. He said families’ “perceptions, politics and religion” impact students’ attitudes and noted that “the kids kind of bring that awareness whether their family has a(n) [environmental] ethic or not.”

Charles had observed that students’ families’ attitudes towards the environment translated into how students approached the subject: “Some kids will have a very strong background, very
strong opinions, and others it’s just kind of wallpaper, ‘it’s a thing that science guys talk about, it doesn’t really change my life, I’m fine, we drive our car, we go to the mall, everything’s fine’.”

Charles found that students who come to his class without an environmental ethic are difficult to motivate. This sometimes resulted in his teaching only reaching those who had been raised to care about sustainability.

Camille indicated that the natural resources of her school also influenced her success. Her school was situated next to “a big back yard and forested gulley” into which she brought her students for hands-on exploratory learning. The convenience of the gulley meant that students got to frequently encounter the natural world first-hand, limiting the abstraction that is common when learning about it in a classroom setting.

This takes a step further than what Reed (2010) described as ‘weaving’ sustainability into teaching. Reed identified the interrelationships of systems involved in climate change and in teaching about it. Camille’s experiences illustrate another interrelationship; how the physical and human landscapes of the school interact to influence her success as a climate educator.

**4.5: Teachers are linking climate change to their mandated curricular expectations by making loose connections to them**

Both of my participants worked within the framework of the Ontario provincial curriculum. As mentioned in chapter 2, the science and technology document does not require teachers to teach about climate change at all (Ontario Ministry of Education, 2007). Instead, both educators are finding ways to link what they are teaching to the mandated document.

Camille’s perspective on curriculum connections was the following: “We have some flexibility within the curriculum so as long as we’re touching the overall expectations, we can
pull it into the needs of our class.” Some of the overall expectations she was referring to included the grade 1 responsibility strand, to which she deemed ‘stewarding the environment’ as the duty on which to focus. In science, she was able to loosely relate climate change to the “needs and characteristics of living things” by illustrating how climate change is making it harder for humans and animals to find enough food and water.

While Camille expanded on what the curriculum requires, Charles had less regard for it: “I look at the curriculum document a couple times a year just as a matter of duty.” He expressed mild disapproval for the curriculum as he derided it for being “too industry focused,” providing limited space for views critical of dominant (carbon-based) modes of production.

Both educators expressed how they were “free” or “open” to do what they wanted in these fields. Camille expressed how she “doesn’t really have to report” on her climate change teaching to administration or to the government. This could help explain why both of them were willing and able to take some latitude on the curriculum. Since they deemed the bulk of their teaching about climate change to be ‘science and social studies,’ they were under less scrutiny than for what they taught in math or language. They say that administrators track students’ mathematical and literacy progress but for other subjects Charles said: “I think, in my own best judgment, and a couple of my colleagues here, we just make our own best decisions.”

4.5.1: Teachers are making the decision to teach about climate change because they personally find it to be very important, not because of a curriculum mandate

As mentioned above, global climate change is not a topic that the participants were required to teach according to their assigned curriculum. Instead, both of them made the decision to teach it due to a deep personal conviction in environmental sustainability.
Camille nevertheless interpreted this work as part of her professional responsibility, telling me: “I think it’s our job to create thinkers that are able to think critically about their actions on the world. So it’s our responsibility to help them understand their role in how everything works around them.” Camille recognized that her students will face many challenges and that all of our everyday actions contribute to those difficulties. What she hoped most for her students was that they develop critical thought through her teaching and use it as a tool to make change.

Charles’s decision to begin to include the topic of climate change occurred when he read the IPCC report in the mid-2000’s. Then, he understood how serious the issue was, and thought it was important for students to learn about climate change since it would affect their world profoundly. He is motivated by the fact that many of his students come from wealthy, privileged families and are likely to become influential decision makers. Consequently, he had foresight to see how instilling ecological ethics in them could have significant impacts.

In her research, Sarah (2010) found that teachers were choosing not to cover the topic due to a lack of understanding. Camille and Charles are exceptions in this regard, demonstrating the kind of instructional possibilities that can be realized when teachers have not only a comprehensive understanding but also a sense of care that can develop from that. Unfortunately, it is unlikely that two isolated K-8 teachers who made the decision to teach about climate change will raise public awareness significantly. Moreover, the agency of these teachers does little to address the lack of understanding that most teachers have on the topic (Sarah, 2010). This will be discussed more in chapter 5.
Neither Charles nor Camille had any clear suggestions about how this should take shape, but both of them agreed that teachers should be free as to how they ought to teach about it. In Camille’s words: “I wouldn’t necessarily say that it needs to be taught in one specific way.”

4.6: Conclusion

Despite the fact that each participant taught at the opposite end of the K-8 grade scale, many similarities are evident from their experiences. Both share a deep personal conviction to sustainability, a supportive environment, a student-lead, constructivist approach to teaching and a liberal attitude toward the curriculum. Some aspects of their pedagogies have implications for the academic literature on climate change education. Camille and Charles’s cross-curricular approach has the potential to expand and deepen their students’ understanding instead of teaching the topic in isolation, which has traditionally been the case (Sarah, 2010, Sharma, 2012). They both allow their students to draw their own conclusions about what they are learning rather than being told what to think which may help them understand what Gonzalez-Gaudiano & Meira-Cartea (2010) describe as the ‘the big picture,’ rather than focusing on sustainability on the individual scale. Furthermore, the age-level to which my participants decided to introduce climate change could help prevent misconceptions observed by Lee et al. (2006) at higher grade levels. Finally, Camille and Charles’s independent decisions to teach about climate change reinforce Sarah’s (2010) argument that teachers are unlikely to cover the topic unless they feel confident in their knowledge about the subject. Their examples highlight what could be achieved in K-8 classrooms should adequate knowledge about climate change be ubiquitous amongst educators. In the next chapter I discuss the implications of these findings for the educational community and for myself as a beginning teacher.
Chapter 5: Implications

5.0: Introduction

In this chapter I provide an overview of my findings and their significance. I then speak to their implications to both the broader educational community as well as for myself as an educator. This section is followed by a list of recommendations I make to educators, administrators, curriculum developers and other members of the educational community. I also recommend some areas for further research given what I found in my own research. I conclude the chapter with some final comments about the significance of this research.

5.1: Overview of the key findings

My participants included Ottawa area grade 1 teacher, Camille Potter and Charles Rice, a grade 8 educator at a Toronto private school. Both of them are homeroom educators. Through this study I found that K-8 homeroom teachers are well-positioned to address the multi-dimensional, cross-curricular nature of global climate change thanks to the fact that they typically teach their students multiple subjects. This enables K-8 educators to weave climate change and environmental sustainability into multiple subject areas rather than discussing them only in science class, a tendency which has been referred to as ‘siloing’ (Sarah, 2010).

Secondly, I found that my participants were both finding ways to engage their students with global climate change by relating the subject matter to their lived experiences and encouraging independent thought. Their students were able to see their role in the cause of, and solution to climate change through these connections made to their individual lives. Both participants refrained from telling their students what to think and instead encouraged them to ask questions and form their own conclusions. As a perceived consequence of this approach to
teaching, both participants observed high levels of student engagement with the topic. Scholars such as Gonzalez-Gaudiano & Meira-Cartea (2010) have derided environmental education which emphasises individual acts of sustainability and overlooks systemic causes of pollution. It is possible that the latitude the participants gave their students in formulating their own conclusions about climate change might help learners bring the ‘big picture’ into focus.

Thirdly, participants observed increased understanding, thoughtfulness and engagement towards the topic of global climate change as their students progressively learned more about it. Judging from anecdotal evidence both inside and outside of the classroom such as well-informed questions asked and comments made, their approach to teaching appears to be effective at helping students learn about climate change and to be mindful of their role as stewards of the environment. Their pedagogies are examples of Agnew’s (2010) assertion that effective ecological education can transform thoughts and ideas.

I also found that a school’s community and its physical environment play an important role in supporting climate change educators. According to my participants, the dispositions of parents, administrators and colleagues play a critical role in supporting or hindering their teaching about global climate change. My data also suggested that physical resources such as proximity to parks can also play a positive role in supporting climate change education. Their example expands upon Reed’s (2010) interwoven approach to climate change education and illustrates the interconnections between a school’s physical and human environments and how they influence educators in their classrooms.

Lastly, my participants were linking the topic of global climate change to their mandated curricula by making loose connections between the topic and the documents. In Ontario where
both participants work, students are not required to learn about global climate change as part of
the official curriculum. Instead, Camille and Charles found ways to link their climate change
content to the mandated subject matter. Both of them share a deep personal connection to
environmental sustainability which led to their decision to emphasize global climate change in
their classrooms. As highlighted by Sarah (2010), not all educators share their passion, or their
knowledge about climate change or environmental sustainability. Their examples paint a picture
of what classrooms could look like if understanding about the topic was more widespread
amongst educators.

5.2: Implications

In this section I discuss the implications of my findings by speaking to the implications
for the broader educational community as well as the implications for myself as an educator.

5.2.1: Implications for the educational community

Camille and Charles’s perceived success in their climate change education indicates that
K-8 is the right time to introduce students to the concept of global climate change. Although one
may intuitively assume that climate change is too complex a topic for younger students to
comprehend, my findings indicate that it is because of this very complexity that educators should
begin teaching climate change in primary school. Primary teachers can better address the multi-
dimensionality of the phenomenon than high school teachers since it is more common for them
to-teach multiple subjects to the same group of students. This means that they can come at the
topic from multiple angles such as the social, scientific and even emotional ones in language arts.
Although primary students may have limited schemas with which to use in learning, Camille and
Charles shared examples that demonstrate how young students can learn this complex and vast topic.

Additionally, Camille’s observation that her students positively responded to the natural landscape affirms the pedagogical power of the physical environment and the implications for student learning through their interactions with it. Some schools may have easier access to parkland, steams or wetlands than others, but Camille’s example shows that taking students outdoors and allowing them to interact with the physical environment broadly speaking can have positive effect on learning and be a powerful way to engage students in learning about environmental topics, including climate change.

Finally, my participants’ reasons for deciding to teach their students about global climate change were based on their own personal views and values. Given the universality of global climate change, the agency of individual educators to teach it or not may be an issue. Leaving the decision to teach climate change in the hands of individual teachers can result in it rarely being taught at all (Sarah, 2010). Curriculum developers need to assess whether this electability is appropriate for a topic which many scientists say is the biggest issue of our time (EPA, 2015).

Beyond the climate change’s explicit inclusion in the curriculum, adequate attention needs to be made to ensure that educators possess a sufficient understanding of the topic themselves. As discussed above, misconceptions held educators has resulted in them being received by their students (Lee et al., 2006). In order to avoid and eliminate these misconceptions as well as provide educators with the confidence and wherewithal needed to teach about climate change effectively, interventions like the one conducted by Hestness et al. (2014) should be provided by education authorities such as school boards or education ministries.
5.2.2: Implications for myself as an educator

A major way in which my findings inform my approach to teaching is how they have affirmed the effectiveness of social-constructivist teaching methods. By building on their students’ previously-held knowledge and inviting them to lead inquiries and draw their own conclusions my participants observed high levels of engagement, understanding and thoughtfulness as outcomes of student learning. From these findings I plan to adopt this approach to hopefully engage my own students with a topic as complicated as global climate change. The form a constructivist activity might take usually depends on the students I would be teaching. Therefore it is necessary to start by having the students brainstorm their pre-held knowledge using some kind of graphic organizer. Once I see what my students know and want to know, that would inform the direction my teaching about climate change would take.

Another thing I learned from my participants’ experiences is the amount of agency teachers have in what and how they teach in their classrooms. The decision to emphasize climate change education in their classrooms was made independently on each of their behalves because it was an issue about which they cared deeply. This gives me inspiration as an educator in that I can choose to teach about issues of personal importance beyond environmental sustainability. Potter and Rice displayed that they can fulfill their curricular obligations and discuss issues of personal importance simultaneously by identifying links between the mandated curriculum and the topics they care about.

Furthermore, my goal as an educator is to help students learn how to solve big problems cooperatively. Since both participants observed increased understanding and thoughtfulness about climate change as a result of their pedagogy, this indicates to me that teaching about these
big and important issues can have positive impacts on students. This finding buoys my
confidence that I can contribute to overcoming big global issues in my role as an educator and
inspires me to seek out colleagues and administrators who might share my convictions so we
might collaborate on certain projects.

5.3: Recommendations

Based upon my findings, I have a series of recommendations to make to the educational
community. They include:

- It is important that curriculum developers create more explicit space for teaching and
  learning about Global climate change in the formal learning expectations across
curricular subject areas, and that curriculum not present this complex issue as an
oversimplified one by stressing dichotomous perspectives.

- When including more explicit attention to climate change in the primary grades, it is
  important that teachers be encouraged to apply inquiry-based constructivist approaches
  that draw on student-generated questions and conclusions.

- In order to obtain a more wide-spread understanding about climate change, teacher
  training programs and professional workshops could emphasize environmental
  sustainability by offering accredited courses on the subject using the same type of
  constructivist methods suggested for students.

- Educators could benefit from seeking out resources available within their school’s
  community, whether that be natural landscapes such as parks, rivers or ponds or human
  resources such as parents, experts, colleagues and administrators.
- School boards and administrators could promote ecology in the community by holding workshops, assemblies, PTA meetings, info nights and newsletters to support the work teachers do in the classroom by acknowledging and addressing the community’s diverse views on the environment. Since students come into the classroom influenced by the views of their families and friends, this dialogue could help to open minds and feelings.

- Educators can help students deepen their understanding about global climate change by allowing them to ask their own questions and form their own conclusions about the information they gathered in pursuit of answers. This can make the learning more meaningful to them as they generate their own knowledge.

- It is important that teachers try to find ways to inspire action on behalf of students beyond turning off the lights and recycling. This could be done by writing letters to politicians, corporations or other policy-makers or by showing solidarity for groups working against climate change such as environmental or indigenous groups in the form of fund-raisers or school rallies.

**5.4: Areas for further research**

Scholars have warned against assuming that increased knowledge and understanding about climate change will necessarily translate into direct action against it (Gonzalez-Gaudiano & Meira-Cartea, 2010; Kegawa & Selby, 2010). Although both participants observed increased interest and importance placed upon the topic the more they learned about it, neither of them reported witnessing resulting actions from students (Taber & Taylor, 2009; Gonzalez-Gaudiano & Meira-Cartea, 2010). Therefore, I would recommend further research be conducted on the ways in which hands-on constructivist teaching methods can translate to meaningful direct action against global climate change. As Selby & Kagawa (2010) noted, individual acts such as
recycling and turning off the lights amount to little compared to the scale of change needed to mitigate the effects of the phenomenon. According to them, meaningful action addresses the larger-scale societal problems we face such as over-consumption, reliance on fossil fuels and our throw-away culture (Selby & Kagawa, 2010). In a classroom setting, this might look like writing letters to politicians, encouraging parents to boycott certain products or attend sessions of government such as parliament or city council. It would be interesting to learn how educators are engendering an activist mindset amongst their students as a result of what they learned.

Secondly, this study was limited in scope to the perspectives of educators themselves. In it we learned how a sample of K-8 educators sees how they are helping their students learn about climate change. I feel there would be a lot to gain from the perspective of the learners themselves. If we were to ask students what they learned and what it means to them, we would have a better understanding of how well students are learning the things which educators hope they would.

Thirdly, my study found that the school community plays a role in supporting educators in their teaching about climate change. Further research could uncover what administrators are doing to enact leadership towards sustainability at their schools both in action and in mindset. How are administrators promoting ecological thought not only amongst the student, body but amongst their school’s teachers too?

### 5.5 Concluding Comments

Camille and Charles perceive their climate change education to help students develop a better understanding of the phenomenon and to increase thoughtfulness towards the environment. Whether or not that will lead their students to take meaningful action to mitigate and adapt to it is
yet to be seen, but their observations display some positive learning outcomes such as the inherent value of developing their students’ ways of thinking.

As discussed in chapter 1, evidence suggests that the general public lacks a sufficient understanding of global climate change to make informed decisions as how to cope with it (National Research Council, 2012). The examples provided by Camille and Charles provide some ideas as to how to develop students understandings of, and interest in, climate change. There are several insights that the educational community can take away from their practices. Foremost, these include the significance of hands-on constructivist teaching methods with students as young as 6 years old to help develop their understanding of a system as complicated as global climate change.

Since the consequences of the earth’s warming are expected to be felt most by today’s school children, the importance of mitigating its effects are all the more apparent for them (Plattner, Gian-Kasper, 2013). This study highlights the role education can play in providing today’s youth with the knowledge required to overcome the challenge. That is why it is of vital importance that educators, administrators and policy-makers learn more about which teaching methods and support factors positively influence this crucial learning.
References:


Appendix A: Consent Letter

Date: ___________________

Dear __________,

I am a graduate student at OISE, University of Toronto, and am currently enrolled as a Master of Teaching student. I am studying how teachers implement climate change education for the purposes of a graduate research paper. Its focus is looking at how primary/junior educators are finding ways to teach such a complex topic in ways meaningful to younger students. I think that your knowledge and experience will provide insights into this topic.

I am writing a report on this topic as a requirement of the Master of Teaching Program. My course instructor who is providing support for this assignment this year is Angela MacDonald. The purpose of this requirement is to allow us to become familiar with a variety of ways to do research. My data collection consists of a 30 minute interview that will be audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient to you, outside of school time.

The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates and/or potentially at a research conference or publication. I will not use your name or anything else that might identify you in my written work, oral presentations, or publications. This information remains confidential. The only people who will have access to my assignment work will be research supervisor and my course instructor. You are free to change your mind at any time, and to withdraw even after you have consented to participate. You may decline to answer any specific questions. I will destroy the audio recording after the paper has been presented and/or published which may take up to five years after the data has been collected. There are no known risks or benefits to you for assisting in the project, and I will share with you a copy of my notes to ensure accuracy.

Please sign the attached form, if you agree to be interviewed. The second copy is for your records. Thank you very much for your help.

Sincerely,

Researcher name: ___Daniel Green______________________________
Phone number, email: ___416-875-5314, dw.green84@gmail.com___________________________

Instructor’s Name: Angela MacDonald
Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw at any time without penalty.

I have read the letter provided to me by Daniel Green and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ________________________________

Name (printed): ____________________________

Date: ____________________________


Appendix B: Interview Protocol

Preamble: Thank you for participating in this interview. This research aims to learn what educators are doing to teach climate change in a way that they interpret to be meaningful to their students. The interview should take about 30 minutes and is broken into 5 parts: Background Info, Teacher Practices, Beliefs and Values, Influencing Factors and Next Steps. I want to remind you that you can decline to answer any of the questions. Do you have any questions before we begin?

Section 1: Background Info

a) What is your name?
b) How long have you been teaching?
c) What grades have you taught in the past?
d) What are you teaching this year?
e) Can you tell me about the school that you teach in? (size, demographics, program priorities)
f) As you know, I am interested in learning how teachers create opportunities for elementary aged students to learn about climate change. Can you tell me how you developed an interest in this topic? What personal, professional, and educational experiences informed your interest and your instruction on this topic?

Section 3: Beliefs and Values

1) Why do you believe that it is important for students to learn about climate change? What do you believe is the role of schools in preparing students to learn about climate change and why?
2) Where, if at all, do you see attention to climate change in the elementary curriculum? (subject areas, grade levels)

3) What would you like to see differently in this respect in the curriculum and why?

4) What do you hope students will gain from your climate change education?

**Section 2: Teacher Practices**

5) Where in the curriculum do you situate your approach to climate change education? (subject areas)

6) What instructional approaches and strategies do you use when teaching about climate change? What approaches do you find to be most effective and why? (listen and then probe re: hands on, experiential, outdoor, student centered, inquiry-based etc.)

7) Generally speaking, how do your students respond to opportunities to learn about climate change? What outcomes do you observe?

8) More specifically, can you give me an example of a lesson that you have designed and taught that focused on climate change?
   a. What grade/subject were you teaching?
   b. What curriculum did you connect to?
   c. What were your learning goals?
   d. What opportunities for learning did you create?
   e. How did your students respond? What outcomes did you observe?

9) What resources support you in your approach to teaching about climate change?

10) What factors do you use when assessing your teaching about climate change?

**Section 4: Influencing Factors**

11) What factors, inside or outside of the classroom, support your teaching of CC?
12) Conversely, what factors hinder your teaching the subject? What challenges have you encountered when teaching about climate change? How did you respond to these challenges? How might the education system further support you in meeting these challenges?

13) What kind of feedback have you received, either from inside or outside the classroom about your CC education?

Section 5: Next Steps

14) What must be included to make a climate change unit successful in your opinion?

15) What advice, if any, do you have for a new beginning teacher who is committed to teaching about climate change?

Thank you again for participating.