Climate Change Education within Canada's Regional Curricula: A Systematic Review of Gaps and Opportunities

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Abstract
This paper reports on curriculum analysis of climate change expectations in Canada's provincial curricula. The research is focused on curriculum policy in Canadian provinces; however, it pertains to an international audience as Article 12 of the Paris Agreement, the international treaty on climate mitigation, adaptation and finance, calls for signatories to "enhance climate change education," and the United Nations Educational, Scientific and Cultural Organization (UNESCO) have called for environmental education to be a core curriculum component by 2025, which will require all countries to evaluate and improve their curricula globally. Curriculum policy within Canada has not yet been aligned with these policy calls, and our analysis showed fractured and uneven inclusion of climate change. Data findings present explicit climate change education curriculum expectations for each province according to grade, subject, and mandatory versus elective courses. The review shows uneven inclusion of climate change topics, themes, and units within grade 7 – 12 curricula, with most expectations occurring in elective senior secondary courses. A second level of analysis with a ranking tool indicates shallow inclusion. The paper concludes with recommendations for addressing gaps.

Keywords: climate change, education, curriculum analysis, formal education Canada

Introduction
Climate change has been identified as a critical issue of our time and the United Nations has highlighted the essential role of climate change education (UNESCO, 2016). This has called for a proactive revamp of the climate change education curriculum within the K-12 school system that is responsible for developing climate change awareness and knowledge as well as mitigation capabilities in young generations. There have been some investigations into how K-12 curriculum has addressed the need for effective climate change education (e.g., Chang & Pascua, 2017, Siegner, 2018; Siegner & Stapert, 2020). However, prior research only focused on case studies of schools implementing the existing curriculum. There is an absence of climate change curriculum review within the K-12 system to provide an overall picture. A question exists regarding the current status of climate change education in curriculum policies.

The research is situated within critical policy studies and aims to provide a review of climate change education curriculum within the Canadian context for researchers and policymakers. This review is timely and salient, given the urgency of climate change, the rise of the youth climate strikes, increased levels of climate anxiety expressed by children and young people, increased climate change education policies globally, and the given evidence of effective climate change education practices. The review is of significance because of the moral, imperative duty of schools to prepare young people for 21st century

contexts and to provide increased climate literacy among the public, along with addressing higher public expectations from school authorities to provide more climate change education. In the literature review, these shifts are foregrounded to give an overview of the dynamic geophysical and social shifts that are unfolding as climate change impacts continue to mount. Beyond this, increasing curricula focused on climate change is important for scaffolding knowledge and climate action explicitly in curricula policy. Without clear policy, climate change education often relies on the competence, dedication, commitment, and enthusiasm of devoted teachers (Eames, 2017; Nicholls, 2017; Whitehouse, 2017). This overview is important to situate climate change education policy within a time of rapid change, uncertainty, and existential stakes.

We aim to address the following questions:

1. What is the current status of climate change education in curriculum policies across provinces in Canada?
2. What are the gaps between learning objective expectations and climate change curriculum? What are the opportunities for closing these gaps?

This paper starts with a literature review, followed by a description of our methodology, including how we developed a ranking system to evaluate existing climate change curriculum under review. We then discuss our findings with recommendations. Finally, a conclusion is drawn with research limitations and future research directions.

Literature Review

In the following review, we discuss the urgency of climate change, the current situation of climate change with youth strikes, and youth's climate change anxiety. This leads to the need for climate change education policy as well as the role of schools in climate change education.

Urgency of Climate Change

According to the UN Intergovernmental Panel on Climate Change (IPCC), humanity has until 2030 to limit warming to 1.5 degrees Celsius (2021). The sixth assessment from the IPCC was termed a "code red for humanity" by the UN Secretary General stressing that "the viability of our societies depends on leaders from government, business, and civil society uniting behind the policies, actions, and investment that will limit temperature rise to 1.5 degrees Celsius" (Guterres, 2021, p.1). Canada's climate policies, as reported in Nationally Determined Contributions assessed as of September 2021, keep Canada on a pathway towards 4 degrees of warming (Climate Action Tracker, 2022).

If humanity fails to keep warming to 1.5 degrees Celsius, we risk destabilizing the 15 geophysical systems that regulate climate (Röckstrom, 2020). In 2021, three of these systems were considered already tipped—disappearance of Arctic Sea summer ice, coral reef collapse, and the disintegration of the west Antarctic ice sheet—and nine of these systems are showing signs of destabilization (Lenton et al., 2019). The impacts from an increasingly destabilizing climate will negatively affect quality of life for much of the world population (Atwoli et al., 2021; Mach et al., 2016; Ripple et al., 2020; World Health Organization, 2018). Even half a degree will significantly worsen the risks of drought, floods, extreme heat, and poverty for millions of people. It will be children and youth who will be living with the effects of climate change for decades to come (UNICEF, 2021).

Rise of Youth Climate Strikes

The youth climate justice movement began in 2015 when a group of students invited youth worldwide to skip school on the first day of the United Nations Climate Change Conference in Paris (Climate Strike, 2016). This first climate strike took place in over 100 countries from Melbourne to Mexico City with more than 50,000 people participating (Phipps et al., 2015). Two weeks later, the Paris Agreement was adopted, which was a "historic turning point for global climate action" with world leaders agreeing on a consensus on an accord with commitments by 195 nations (Denchak, 2021, para 2).

In late August 2018, Greta Thunberg initiated her school strike for climate. By March 15, 2019, a global climate strike was organized with 2200 events across 125 countries that engaged 1.6 million people. The momentum continued to grow with the Global Week of Climate Action in September 2019 with 4500 events across 150 countries, engaging close to 7 million people. The school strikes strengthened the

reach of the youth climate justice movement, which is now considered the largest environmental and social movement in history (Bowman, 2020). Thunberg's leadership has led millions of youths worldwide to take to the streets, become engaged in civic action, demand government action to reduce greenhouse gas emissions and phase-out fossil fuels, and in some instances, demand curriculum reform. The climate strike movement is a symbol of the concern that young people have for their futures and the slogans on climate strike placards often convey imperative climate actions as well as for complex intersectional justice (Bowman, 2020).

In some countries, the school climate strike focused on improving climate change education with youth organized groups like Teach the Future in the UK (2021) or Climate Education Reform British Columbia (CERBC) in Canada (2021). CERBC launched a campaign *Reform to Transform* in April 2021, which consists of a list of needs for the BC Ministry of Education to respond to and a well-organized campaign to bring pressure to bear on the ministry.

Beyond curriculum reforms, the group has also asked for the creation of a youth advisory committee that would work alongside the BC ministry of education and individual district-level committees to ensure that student voices are consistently heard. The work of CERBC and Teach the Future are examples of inclusive and well-organized youth campaigns to demand more climate change education in the existing formal educational system.

Levels of Climate Anxiety among Children and Youth

A growing body of academic research suggests that children and youth may be at a greater risk of experiencing eco-anxiety than adults (Clayton, 2020; Ojala, 2012). In US research, 82% of ten to twelve-year-olds expressed feelings of fear, sadness, and anger when discussing environmental issues (Burke et al., 2018). In Canada, the national survey conducted by Field et al. (2019) completed an engagement ladder analysis (LaChappelle et al., 2016) and found that Canadian youth between 12 - 18 years of age were categorized as 'aware,' meaning they understood that anthropogenic climate change was happening, but they did not believe that human efforts will be effective in mitigating the impacts. An international study of 10,000 young people between ages 16 – 25 from 10 different countries reported that 75% of young people agreed that "the future is frightening," more than half indicated that they felt they will have fewer opportunities than their parents, and climate anxiety and distress were correlated with perceived inadequate government response and associated feelings of betrayal (Hickman et al., 2021). Recent survey research among Canadian youth showed similar results, for example, 39% of young Canadians (aged 16 -25) report hesitation about having children due to climate change, 48% believe that humanity is doomed, 53% think that they will not have access to the same opportunities that their parents had, and 76% report that people have failed to take care of the planet (Galway & Field, 2023). In the Canadian survey research, young Canadians were also asked what formal education systems can do to support young people's mental and emotional heatlh in the context of the climate crisis. The top 3 themes indicate directions for education: 1) increase climate change content in school, 2) teach solutions, and 3) provide mental health supports such as counselling, student support groups, and explicitly integrate coping strategies (Galway & Field, 2023)

Eco-anxiety among young people may also be fueled by collective senses of despair in media coverage, activism, and society at large (Nairn, 2019), as these spaces are often bereft of messages of hopeful, though climate-altered, futures. It is argued that children are suffering emotional and psychological anguish not always from their direct lived experiences but in anticipation of an apocalyptic future they think is inevitable (Kelsey, 2020).

Our view is that climate anxiety is an appropriate response to the current climate reality (Macy & Johnston, 2012) and research statistics on levels of youth eco- and climate anxiety bring forward the question of how education systems can better provide opportunities that respond to the gaps in climate change education curriculum policy or learning experiences that attend to the socio-emotional dimension of learning about climate change.

Climate Change Education Policy

Within the 1992 UN Framework Convention on Climate Change (UNFCCC) is Article 6, which focuses on Education, Training, and Public Awareness. It was reinstated as Article 12 of the Paris Agreement

(United Nations Framework Convention on Climate Change, 2015). These articles are the primary focus of Action for Climate Empowerment strategies, which create the legal basis for accelerating climate action (Cintron-Rodriguez et al., 2021). Canada, as a signatory to the Paris Agreement, agreed to Article 12 which calls on parties to "enhance climate change education, training, public awareness, public participation, and public access to information, recognizing the importance of these steps with respect to enhancing actions under the Paris agreement" (p.16).

Following the fall of 2019 and the growing momentum of the youth climate strikes and increased climate advocacy, several education systems responded by legislating climate change education as a mandatory subject (Italy, New Zealand, Colombia, and the states of Islamabad, and New Jersey), while others launched efforts to improve the quality of climate change education (Greece, Scotland, Mexico, Cambodia, and UK). Adding pressure to the climate change education policy context, UNESCO declared that environmental education must be a core curriculum component by 2025 (UNESCO, 2021). A comprehensive review of countries' focuses on climate change education through analyzing their Nationally Determined Contributions to the UNFCCC Secretariat showed that there were notable gaps in climate change education and communication activities, and a pronounced emphasis on cognitive knowledge over affective or action-oriented approaches (McKenzie, 2021).

National reviews of policy have also identified the lagging leadership and responsiveness to engage in meaningful ways with climate change education. According to a national evaluation of climate change education policy in Canada (Bieler et al., 2018), provincial and territorial policies for formal education (K-12) demonstrated: "1) shallow engagement with climate change 2) an overwhelming focus on energy efficiency upgrades in schools and, 3) a lack of holistic responses to climate change" (p. 63). Another recent national evaluation of climate science curricula (Wynes & Nicholas, 2019) found that Canadian curricula focused predominantly on human-caused global warming but did not sufficiently address the scientific consensus, climate impacts, or solutions. Furthermore, within Canada, only one ministry of education (British Columbia) had issued a policy statement on climate change education, although, some school boards had released position statements as well as declared states of emergencies. Situated in the Canadian education context, this research provides benchmarks of climate change education curriculum and outlines where there are gaps and opportunities for responding to the climate crisis within educational curriculum policy.

Effective Climate Change Education

There has been a sharp increase in global research focused on climate change and education over the last several decades—with only 12 articles between 1990 and 1999, 433 articles between 2000 to 2009, and 1489 articles from 2010 to 2015 (Monroe et al., 2017). Since the last comprehensive and systematic literature review, there has been a continued proliferation of research articles. Within this emerging area, there is a growing empirical evidence base of effective climate change education strategies from student-based collected data and teacher-based studies (Bhattacharya et al., 2020; Monroe et al., 2017). Nevertheless, within the broader climate change education field, there is little consensus on what climate change education is, the best program delivery model, who will be responsible for ensuring quality climate change education, how to modify educator's practices to ensure climate change education is fit for the purpose, or how to assess, evaluate, or research climate change education (Reid, 2019).

Conventional practices of climate change education have mostly focused on students learning scientific knowledge (Brownlee, 2013; Gonzalez-Gaudiano & Meira-Cartea, 2010; McKenzie, 2021; Wibeck, 2014). In this way, there has been a predominant focus on 1) the physical mechanisms of climate change and the validity of climate science and 2) how to address misinformation or climate denial (Henderson, 2019). A recent review of Canadian climate change education took six core topics from the IPCC fifth assessment to evaluate provincial and territorial curriculum documents (Wynes & Nicholas, 2019). This study showed "that many provinces neglect to choose standards that go beyond scientific literacy" (p.14) and select to focus on declarative or substantive knowledge of climate science. Wynes and Nicholas (2019) argued that curriculum policy documents miss opportunities for procedural or effectiveness knowledge such as solutions-focused climate mitigation actions and a preference for content-knowledge over civic-oriented teachings. Their analysis showed some important gaps within teaching the science of climate change education but was too limited when one considers the transdisciplinary nature of climate change and climate change impacts. A holistic and interdisciplinary review is needed.

There is an assumption within science and environmental education that increased knowledge will lead to attitudinal change and in turn, pro-behaviour change; however, this persistent assumption has long been challenged within environmental education theory (Kollmuss & Agyeman, 2002) and within climate change education by the knowledge to practice gap found in the mounting evidence where higher levels of scientific knowledge do not result in direct or equivalent behaviour modifications (Hornsey et al., 2016; Kahan et al., 2011; Kabisch et al., 2016; Knutti, 2019; Lee et al., 2015; Schome & Marx, 2009).

Beyond the knowledge-to-practice gap, a recognition of the importance of analyzing power within climate change education has mostly been missed. The youth climate strike movement has been successful in bringing forward issues of climate injustices, such as intergenerational, economic, and racial inequity to the public (Grewal et al., 2022) and in general, youth climate activist groups take an intersectional view of climate actions (Bowman, 2020). However, environmental education practices within schools have had a predominant focus on individual behaviour change (Chawla & Cushing, 2007) rather than focusing on engaging in civic-oriented change making processes that shift how state or corporate actors behaved. Critique against individually focused climate behaviours has emerged as part of neoliberal discourse that fails to address the greenhouse gas emissions caused by corporate actors (Eaton & Day, 2020; Henderson, 2019; Lukas, 2017). Research has shown that reduction in greenhouse gas emissions on an individual behaviour's basis will not result in humanity collectively keeping warming to 1.5 degrees. Instead it requires government and corporate leadership (IPCC, 2021). Therefore, we are arguing that climate change education must move beyond scientific or environmental literacy and directly engage with the social, political, and economic dimensions of climate change.

Within the emerging evidence base of effective climate change education, Monroe et al. (2019) identified that teaching strategies that focused on making climate change information personally relevant and engaged learners through activities or active educational interventions were shown to be empirically effective. Other educational researchers and educators have argued that the practice of climate change education needs to broaden to include socio-emotional (Kelsey, 2020; Kretz, 2012; MacKay et al., 2021; Ray, 2020), action-oriented (Eames, 2017; Jensen & Schnack, 2006; Stevenson et al., 2017), and justice-focused dimensions (Hargis & MacKenzie, 2020; Marris, 2019; Haluza-Delay, 2013). For instance, research indicated that collective identities influenced climate change norms as well as efficacy and emotions (MacKay et al., 2021), reflecting a need to provide inclusive and well-rounded climate change education at schools. Teachers should teach students to engage in climate actions and prepare them for future climate change mitigation and adaptation measures (Stevenson et al., 2017). Moreover, climate justice, which has been declared and demanded in youth climate activism movements, should be included in the curriculum (Marris, 2019). With a broader and transdisciplinary framing of climate change education unfolding, coherence across the emerging field is still very much evolving.

Moral Imperative and Duty of Schools

Beyond the Paris Agreement, there is arguably a moral imperative for schools to improve climate change education based on the rights of children and the concept of 'duty of care' that is outlined within Canadian Education Acts. In 1991, Canada ratified the United Nations Convention on the Rights of the Child (UNCRC), which provided a foundation for the protection of children's rights globally. This right was previously outlined in the earlier International Covenant on Economic, Social, and Cultural Rights, which was also used to ground children's rights in Ontario and other provinces. The UNCRC has not been formally adopted into domestic law and, therefore, it is not legally binding.

It is argued that it should underlie Canadian law and policy for two reasons: 1) the Canadian Charter of Rights and Freedoms is presumed to provide at least as great a level of protection as found in Canada's international human rights obligations (Halsbury's Laws of Canada, 2018) and 2) that statues should be construed consistent with international obligations (Chow, 2021). This suggests a moral obligation for policy-makers to ensure policy is aligned with the UNCRC, wherein children have a right to survive (Article 6), to develop to the fullest, to be protected from harmful influences, abuse, and exploitation (Article 19), to access education (Article 28), and to access an education system that helps develop every child's personality, talents, and mental and physical abilities to the fullest— including respect for children's rights (Article 29). Additionally, Article 12 of the UNCRC also empowers children and young people to be actively involved in decisions that affect them and to have their opinions considered by adults, which implies that children can negotiate with adults and caregivers to determine the quality and nature of the

services and infrastructure that is provided to them (Bala & Houston, 2015). Internationally, youth plaintiffs have become increasingly successful in cases that argue intergenerational inequity based on human rights law against government policies; however, we are not aware of any cases where education systems have been held accountable by the UNCRC with a climate argument. In a Canadian policy context, the Education Act and its regulations provide the statutory basis for how education is delivered to students who are enrolled in publicly funded school systems within each province or territory. An in-depth analysis of the legal statutes of 'duty of care' and what 'duty of care' means for schools during the climate crisis is worth investigating but goes beyond the scope of this paper.

Support for improved climate change education policy in Canadian schools

Lastly, there is support for improved climate change education in Canadian schools from the public. The report, *Canada, Climate Change and Education: Opportunities for Public and Formal Education*, shares findings from a comprehensive national survey (n=3196) that reflected the widespread support among the Canadian public for improved climate change education in schools. It reported that two-thirds (68%) of Canadians and 80% of teachers believed that schools should be doing more to educate students about climate change (Field et al., 2019). This report also showed that there is limited class time spent on climate change content with between 33% (closed-sample) and 59% (open-sample) of teachers reporting teaching any climate change topic. For the teachers who did integrate climate change content, most students experienced 1-10 hours of instruction per year or semester (Field et al., 2019). Only 32% of closed-sample teachers felt that they had the knowledge and skills to teach about climate change, indicating the need for professional development, classroom resources, and curriculum policy (Field et al., 2019).

It is noted from the literature review that the need to embed climate change education within the K-12 curriculum is urgent. There has been support for enhancing climate change education in Canadian schools. However, there is an absence of a clear understanding of the current status of climate change education in the K-12 curriculum and whether or not the existing curriculum can address the expectations regarding learning objectives in terms of climate change awareness, knowledge, and action. Our paper therefore aims to fill this gap by providing an intensive review of existing climate change education curricula within the K-12 system across all provinces of Canada.

Theoretical Framework and Methods

To address the research questions, we conducted a research project to gather existing curriculum policies from all provinces in Canada for evaluation of existing climate change education by using a self-developed ranking system based on prior literature. Our research project adopted the BEKA model of curriculum analysis as suggested by Hall (2014) and as described later in this section.

Within policy studies, 'policy' can be considered as a culmination of the values and priorities that inform decision-making (Easton, 1953). Moreover, policy can extend beyond policy texts themselves and include authoritative statements which seek to frame or shape educational practices such as mission statements, curriculum guides, or building design frameworks (Ball, 2012, 2015; Ozga, 2000; Rickinson & McKenzie, 2021; Taylor et al., 1997). Within policy research, what is not included in policy or in 'non-decision making' (Ozga & Lingard, 2007) is also relevant as it indicates what policymakers do not prioritize or see as relevant and, therefore, engages with "highlighting the politics of policy," through critically engaging with influences on and impacts of policy that might not be asked otherwise (Rickinson & McKenzie, 2021; Simons et al., 2009). Therefore, this research is situated within critical policy studies to outline how current curriculum policy frames climate change education with the intention of informing where there are gaps and identifying the opportunities for improving it.

For this research project, content analysis methods were applied on publicly available curriculum documents (with the exception of new pilot curriculum documents that were shared with researchers) in a systematic approach through applying a keyword search (Hall, 2014) of 'climate change'. This research study focused on evaluating the overt and explicit curriculum and did not assess the hidden, unintended, or covert curriculum (Cornbleth, 1984; Hall, 2014; Miller & Seller, 1990), 'non-decision making" in policy texts, or how teachers' may view curriculum and apply to their practice.

This research project followed the BEKA model of curriculum analysis (Hall, 2014). The BEKA model draws upon the work of Glatthorn (1987), Print (1993), and Reid (2005) to develop a four-step

process for evaluating curriculum: benchmarking, evidencing, knowing, and applying (BEKA). Benchmarking is a process of measuring, judging, and evaluating a standard, a reference point, or a criterion against which the quality of something can be measured (Vlãsceanu et al., 2007). The benchmarking in this research related to the quantitative results of the number of climate change education expectations for each province/territory in the Canadian context.

The evidencing process aimed to ascertain the relative emphasis given to each topic. For this research, the evidence process moved beyond the quantification of the number of climate change education expectations and focused on assessing curriculum expectations according to a ranking system which was developed from empirical research studies on effective climate change education. The last two stages of the BEKA model, knowing and applying, are important steps but fall outside the research parameters of this study given the federated education system which decides on curriculum policy. The last two stages of knowing and applying could be led by Ministries of Education to inform the further development of climate change curriculum.

This review of climate change education expectations in policy is limited in assessing climate change education practice in classrooms. Teachers' integration of climate change content into their teaching practice is influenced by their beliefs and views on curricula relevant to their teaching practices—since teachers view policy, curriculum, and professional practice through their personal worldview and sense of professional ability (Cotton, 2006; Cutter-MacKenzie & Smith, 2003; Stevenson, 1987). Due to the political and ideological discourses involved in climate actions and climate change education, a holistic analysis of curriculum policy, school culture, and teacher practice is required to speculate on how curriculum policy translated into teacher practice.

Data Collection

A systematic content analysis of the ministry of education curriculum documents for grades 7-12 from each of Canada's 13 provinces and territories was conducted. In the territories (Yukon, Northwest Territories and Nunavut), some documents were used from partnering provinces and were noted for what grade and subject this occurred for each province and territory, and initially, the most recent publicly available curriculum documents were selected. The curriculum documents were initially collected and analyzed in the winter of 2019. In late 2020 and into the early spring of 2021, documents were checked whether they were up to date and reliability checks on searches and ranking were conducted. Differences in number of expectations or rankings were then reconciled between reviewers. However, not all documents were publicly accessible for all grade levels. The researchers contacted respective curriculum advisors from provinces or territories to confirm that the researchers had access to all relevant curriculum documents.

Climate Change Keyword Search

To review climate change content integration, a keyword search was conducted looking for the term "climate change" across all policy documents. This allowed us to directly find where climate change was mentioned across curriculum policy documents and then to further analyze the policy documents to determine the level of depth of climate change integration. The researchers piloted several keyword search combinations before agreeing that the keyword, "climate change" resulted in the most relevant and accurate results for finding curriculum expectations where climate change concepts were taught.

The initial keyword search was conducted by one researcher who documented their findings in a research journal. A second keyword search was conducted by another researcher to ensure that all climate change education expectations were identified. Where there were any discrepancies, the two researchers discussed until there was consensus on the number of expectations.

Ranking

There is no official system from respective authorities for ranking climate change integration in the curriculum as of the time of this analysis (Reid, 2019). While the importance of climate change education is acknowledged, there is an absence of understanding how this can be operationalized into the curriculum (Chang & Pascua, 2017). From this information, a ranking system was also developed as a second layer of analysis to assess how curriculum expectations aligned with broad best practices of climate change

education.

Development of Ranking Scale

According to Hargis and McKenzie (2020), good climate change education had four characteristics: (1) "be accurate and critical", (2) "be local and tangible", (3) "include social and emotional aspects"; and (4) "support action" (p. 3). In other words, scientific literacy was essential (Brownlee et al., 2013; UNESCO, 2019; Wibeck, 2014) but not sufficient for behavioral change (Callison, 2014; Hornsey et al., 2016; Lee at al., 2015). Moreover, research showed that good climate change education must put students in a learning environment that can activate social and emotional considerations (González-Gaudiano & Meira-Cartea, 2010; Monroe et al., 2019). That indicates how climate change curriculum should allow for students to reflect on their own experiences and engage in solutions within their immediate social contexts (Monroe et al., 2017).

To maintain consistency of curriculum assessment, we developed a ranking system to assess climate change integration in school curricula based on previous studies which had established principles of climate 'literacy', including knowledge, behavior change, and action-oriented engagement dimensions to describe learning outcomes (Jensen & Schnack, 2006; Siegner, 2018). First, climate change education must produce climate knowledge (Siegner & Stapert, 2020) which is personally relevant and meaningful (Monroe et al., 2019). Accordingly, climate change knowledge should be scaffolded to suit respective grades in the school system so that students can comprehend climate change concepts and impacts. Secondly, climate change education should be put in real contexts (Hargis et al., 2020) to support changes at personal and local levels (Li & Munroe, 2019). Third, research has demonstrated that to engage students into change learning, climate change education should be action-focused, leading to active participation (Hermans & Korhonen, 2017) and social political actions (Hargis et al., 2020) such as behavioral change and community engagement (Bieler et al., 2018; UNESCO, 2016). Ideally, climate learning outcomes should engage students in action for climate change learning as well as communication and participation with the wider community (Beveridge et al., 2019; Wibeck, 2014). Therefore, the proposed ranking system reflected varying levels of climate change integration which would result in varying levels of learning outcomes related to knowledge (concepts and impacts), behavioral change, and action.

Based on the above considerations, we created a ranking system to assess climate change curriculum. Our ranking reflects varying climate learning outcomes and uses an ordinal rating of 0-3 as in the climate education engagement scale which was developed by Bieler et al. (2018), based on Agyeman's (2005) Just Sustainability Index (JSI). Bieler et al's (2018) scale was used for assessing the extent of engagement with climate change education in educational policy documents, ranging from 0 (no mention of climate change) to 3 (outlining specific climate change targets). The distinction of our ranking system is that it was developed to assess climate change integration as reflected in school curricula and not within educational policies. Hence, using the ordinal rating of 0-3 (Agyeman, 2005; Bieler et al., 2008), and reviewing principles of climate learning outcomes (Beveridge et al., 2019; Hargis et al., 2020; Jensen & Schnack, 2006; Siegner, 2018; Siegner & Stapert, 2020, UNESCO, 2016; Wibeck, 2014), we developed a climate change integration ranking scale to assess varying levels of climate change integration that produced varying learning outcomes (see Table 1). The ranking system allows for a deeper analysis of each curriculum and its engagement with higher orders of thinking and action. This system was consistently used in our analysis of climate change education as reported in our paper. One researcher conducted the evaluation and ranking of the curriculum initially, followed by another researcher in our team independently reviewing the curriculum. Where there were discrepancies in ranking values, the researchers discussed their rationales until they found consensus.

Table 1
Climate Change Integration Ranking Scale (Scale 0-3)

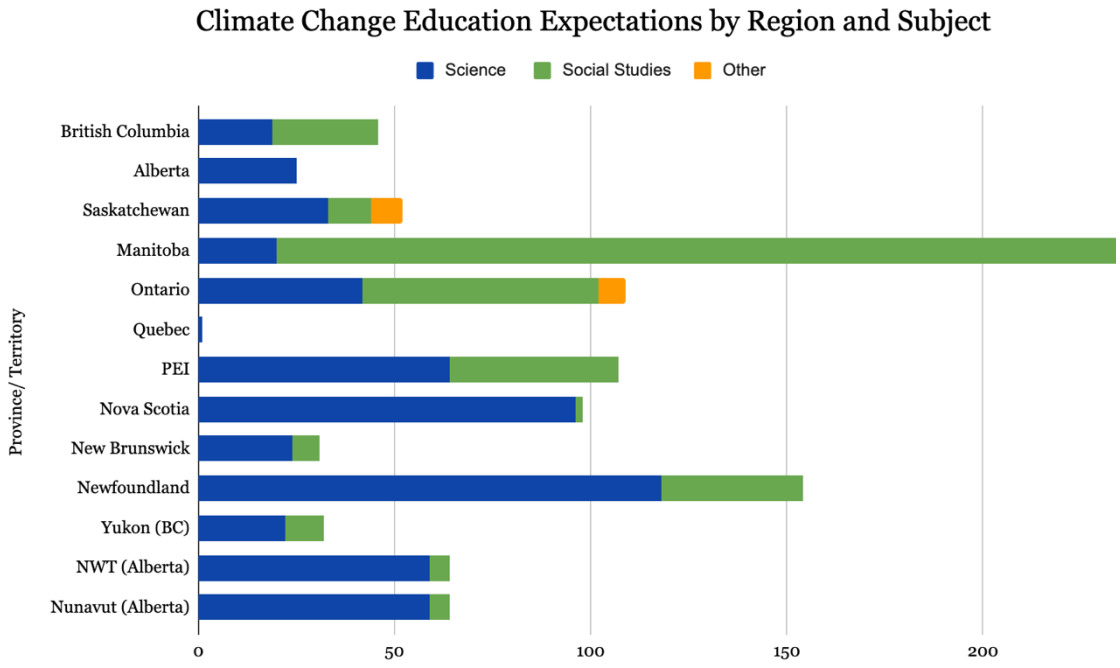
0	1	2	3
No climate change expectations	Focused on understanding climate change concepts and/or impacts	Analyzing, interpreting, assessing climate impacts or mitigation initiatives	Acting on climate change learning, communicating to the wider community, project-based climate change learning

Results and Discussion

Curriculum Analysis Overview

Our findings show the total number of times "climate change" was found in science, geography, and other courses across the grade 7 - 12 subject curriculum documents across provinces and territories in Canada.

Figure 1
Climate Change Education Expectations by Region and Subject



Note. This figure shows the total number of times "climate change" was found in science, geography, and other courses throughout each respective province/territory's curriculum.

From this preliminary step of analysis, the data showed that there was uneven inclusion of climate change expectations across the curriculum. For many provinces, most climate change expectations occurred within science courses (Alberta, Saskatchewan, PEI, Nova Scotia, New Brunswick, Newfoundland, Northwest Territories, and Nunavut). However, this was not the case for other provinces where there were far more climate change expectations in social studies than in science courses (such as Manitoba and Ontario). For instance, in Manitoba, there were 216 climate change expectations in Social studies courses and 20 in science courses. In Ontario, there were 60 climate change expectations in Social studies courses and 42 in science courses. (For a detailed overview of number of expectations for each regional curriculum by grade, subject, and course, see supplemental file.) The results from the review

of Quebec's curriculum were completed by two researchers and then sent to three other educational researchers with familiarity with the Quebec curriculum. There was only one explicit climate change expectation in the Quebec Grade 11 Science & Technology curriculum; however, there were five broad areas of learning such as environmental awareness, citizenship, health, and well-being, which allowed for teachers to connect student learning with climate change and other specific issues. Therefore, the results of the Quebec review need further qualitative follow-up by education researchers with knowledge of Quebec's educational policy to complete a thorough analysis of climate change expectations in the province. Overall, these differences across the regions indicate policy incoherence and uneven inclusion across curricula on the integration of climate change concepts.

The inconsistent coverage of climate change topics, themes, and units across provinces can be connected to the date of release of the curriculum documents. Across all provinces, curriculum documents that were still in use but were more dated generally did not discuss climate change as often, and if they did, the focus was on climate science. Connecting this to the ranking tool, this indicated a shallow coverage or inclusion of climate change but did not limit what educators chose to include in their teaching practice.

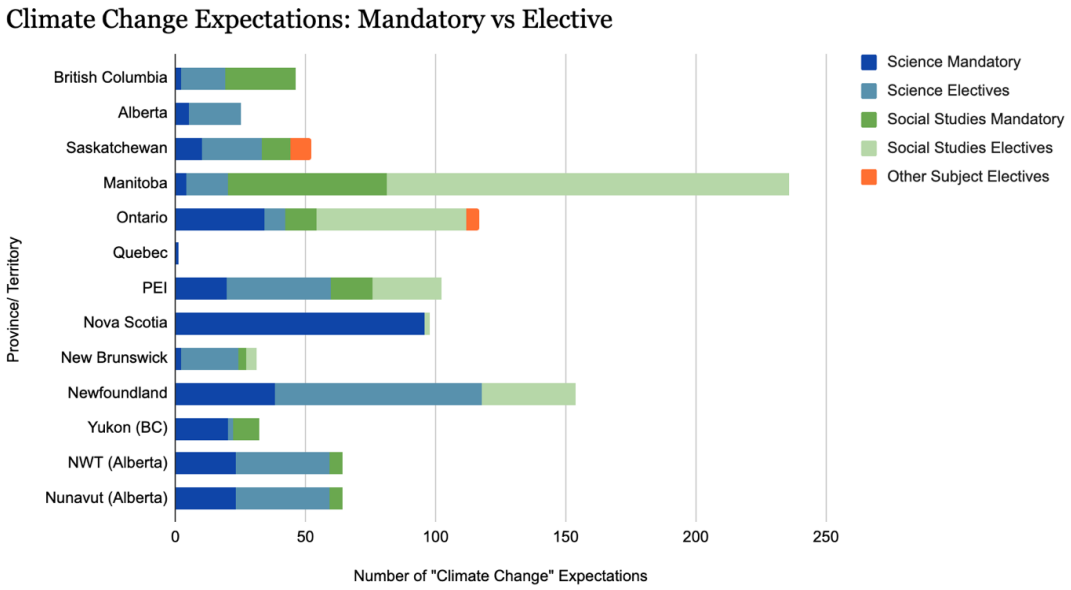
The results of this paper were also informed by a previous study of climate change expectations conducted by Wynes and Nicholas (2019) in which the authors interviewed contributors to curriculum documents to better understand the process of curriculum development in each region. Interviews with six science consultants and contributing teachers showed that "moderate differences in the curriculum development process...appear[ed] to be responsible for the variations between provincial curriculum documents on the topic of climate change (as opposed to external factors such as political input)" (Wynes & Nicholas, 2019, pg. 8). According to the interviewees, the process for selecting individuals to contribute to curriculum design varied from formal application processes and recommendations from school boards to hiring due to circumstance (Wynes & Nicholas, 2019). The interviewees in this study also indicated that numerous factors influenced the amount of space in the curriculum given to climate change, including feedback from teachers, input from faculties of education, environmental groups, approaches taken by other provinces and jurisdictions, and the availability of teaching resources for the subject. In addition, there was a lack of policy at the ministry level which guided climate change curriculum policy. Several policies informed climate change integration such as the Common Framework of Science Learning Outcomes K to 12 or the global competency framework put forward by the Council of Ministers of Education, Canada. However, these broader policy frameworks were not specifically targeted to address climate change education and, according to Wynes and Nicholas (2019), only some provinces relied on them more than others.

Given the findings from Wynes and Nicholas (2019), it is not surprising that there is substantial policy incoherence in the coverage of climate change content. This incoherence stemmed from and included the selection of who was hired to complete the curriculum review, varying factors that influenced how much space was allocated to climate change in the curriculum, and the lack of ministerial policy on climate change education.

Recognizing that students begin to choose their courses at the senior secondary level, our research team decided to also evaluate climate change expectations by separating where climate change expectations occurred between mandatory and elective courses. Courses between grades 7 - 10 were considered mandatory while courses taken in grades 11 - 12 were considered electives as students could choose which science and social studies and/or other electives they would take. While many provinces required one additional science or social studies course in Grade 11 or 12, it was not guaranteed which course will be selected. Therefore, none of the senior courses were included as mandatory courses.

Figure 2

Mandatory vs Elective Climate Change Expectations



Note. This figure shows the number of mandatory vs elective climate change expectations that were found in science, geography, and other courses throughout each province/territory's curriculum.

When the data was parsed between mandatory and elective courses, another level of policy inconsistency became evident. For instance, in British Columbia, there were two climate change expectations in mandatory science courses and 17 climate change expectations in elective courses whereas there were 27 climate change expectations in mandatory social studies courses and zero in electives. Provinces with more than 50% of climate change expectations in mandatory courses were British Columbia, Nova Scotia, and the Yukon (and Quebec; however, there were so few expectations in the Quebec curriculum that it was not considered). Most of the climate change expectations occurred in elective courses at the senior secondary level for the rest of the provinces: Alberta (20%), Saskatchewan (40%), Manitoba (28%), Ontario (38%), PEI (37%), New Brunswick (16%), and Newfoundland (25%). This data illustrates the lack of priority of mandatory climate change expectations within curriculum documents. Provinces that have more recently undergone moving curriculum towards competency-based approaches have higher percentages of mandatory climate change expectations: British Columbia (63%) and Nova Scotia (98%).

Table 2

Mandatory vs Elective Climate Change Expectations

	Science-M	Science-E	Social Studies-M	Social Studies-E	Other Subject Electives	% of CCE in Mandatory Courses
BC	2	17	27	0	0	63%
AB	5	20	0	0	0	20%
SK	10	23	11	0	8	40%
MA	4	16	61	155	0	28%
ON	34	8	12	60	5	38%
QC	1	0	0	0	0	100%
PEI	24	40	16	27	0	37%

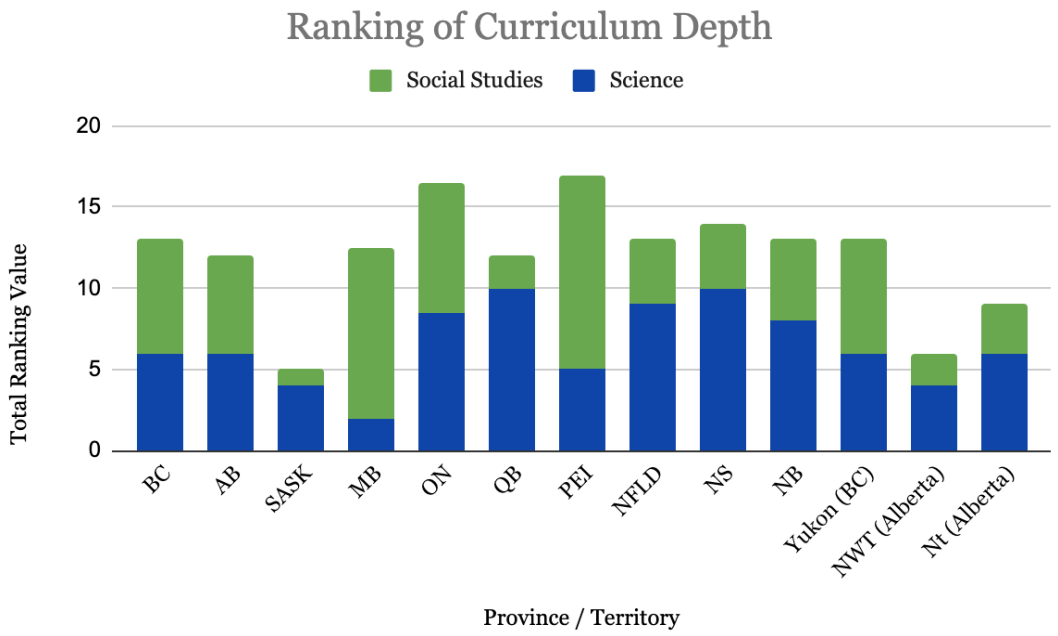
	Science-M	Science-E	Social Studies-M	Social Studies-E	Other Subject Electives	% of CCE in Mandatory Courses
NB	2	22	3	4	0	16%
NFLD	38	80	0	36	0	25%
Yukon (BC)	20	2	10	0	0	94%
NWT (Alberta)	23	36	5	0	0	44%
Nunavut (Alberta)	23	36	5	0	0	44%

Note. The table depicts the number of climate change expectations in mandatory (M) and elective (E) courses. The last column shows the percentage of climate change expectations (CCE) in mandatory courses. A higher percentage indicates that most expectations were found in mandatory courses while a low percentage indicates most expectations were found in elective courses. Quebec is an outlier as the province only had one climate change expectation.

Wynes and Nicholas' (2019) study found that Saskatchewan's provincial curriculum had the best coverage of climate change according to the six topics related to the IPCC framework; however, only 40% of those expectations occurred in mandatory courses. This was an important distinction and consideration for curriculum review development processes as not all students would take senior secondary elective courses such as Environmental Science, which had 18 of the 33 climate change expectations that occurred within all science courses in Saskatchewan. Another data point of interest was in Manitoba, with 155 elective climate change expectations in social studies courses. However, all of these elective expectations occurred in a Grade 12 Global Issues course. This course was a strong example of a course that engaged deeply with climate change concepts from both a scientific and social science perspective through inquiry processes and critical questions (see the bright spot section for a more detailed review).

To further investigate climate change expectations within the curriculum, we applied the Climate Change Integration Ranking Scale (see Table 1) to each provincial and territorial curriculum document. The ranking scale, informed by climate change education research and best practices, recognized scaffolding climate learning through three levels. Scaffolding started with developing increased levels of climate literacy (level 1), followed by acquiring critical thinking abilities to analyze, interpret, and assess climate impacts of mitigation initiatives (level 2) and acting on climate learning (level 3) through project-based learning or communicating with a wider community.

Figure 3
Ranking of Curriculum Depth



Note. This figure shows the overall ranking of each province for science, social studies, and other courses where climate change was discussed in the curriculum. While each subject has a specific ranking, the graph illustrates the total ranking summary for either science or social studies subject areas for that province. This is calculated by adding the rankings for each course or grade together for each province or territory. (Please write to authors if you would like to see detailed notes on curriculum ranking by province, grade, or subject).

The overall ranking depth of curriculum resulted in high scores in PEI (17) and Ontario (16.5). Through this analysis, there were several courses that ranked at 2.5 or 3. In PEI, social studies courses from grades 8 - 10 were ranked at a level 2 because of engagement in critical thinking about climate change. Also in PEI, Grade 11 and 12 elective social studies courses engaged in project-based learning around climate change and were ranked at level 3. Ontario's social studies and science courses were ranked at a level 1 or 2. However, the Grade 10 Science Unit was assessed as a 2.5 as there was only one expectation that operated at level 3, which was "D2.5" where students engaged in calculating their carbon footprints using a computer simulation and then planned a course of action to reduce their carbon footprint. Our research team decided to rank this a 2.5 since the climate actions that the curriculum were supporting were individual actions and it failed to consider the larger societal changes required for mitigation targets to be met. Overall, most curriculum expectations engaged with climate change at a level 1 or level 2 across the regional curriculums, with very few ranked at a level 3, which involved taking climate action.

Table 3
Climate Change Expectations Ranking Results by Level

Province	# of Level 1 CCE	# of Level 2 CCE	# of Level 3 CCE
BC	4	3	1
AB	4	1	1

Province	# of Level 1 CCE	# of Level 2 CCE	# of Level 3 CCE
SK	1	2	0
MA	2	3	1
ON	2	7	1
QC	0	6	0
PEI	1	5	2
NFLD	1	1	2
NS	4	5	1
NB	3	2	1
Yukon (BC)	4	3	1
NWT (Alberta)	4	1	0
Nunavut (Alberta)	5	2	0
Percentage of total CCE assessed	40%	47%	13%

Note. The table shows the ranking results of courses based on applying the Climate Change Integration Ranking Scale to the climate change expectations (CCE) found within the course. Two courses were ranked at a 2.5 level and were included in the table as level 2's.

The ranking results showed that curriculum documents focused on developing knowledge about climate change (40% at level 1) and learning related to analyzing, interpreting climate impacts, or adaptation strategies (47% at a level 2). Lastly, only 13% of courses had climate change expectations that focused on acting on climate change learning.

In our review, there were some curriculum policy sections that were notable in considering future steps for developing climate change curriculum. These "bright spots" were provided as a supplemental file.

Recommendations

The findings of the curriculum review showed inconsistent and uneven coverage across provincial and territorial jurisdictions when it came to climate change education. Stemming from this review, we outline several recommendations for improving climate change education curriculum along two lines: 1) substantive content improvements to curriculum and 2) opportunities for administrative leadership and climate action to improve climate change education.

Substantive improvements

Curriculum reviews should first prioritize addressing climate change education expectations within mandatory subjects. As seen in the data collected (Fig. 2) climate change topics, themes, and units were included in elective Grade 11 and 12 courses. The main problem that existed was how these elective courses were not offered every year. This could be due to smaller school communities and not as many courses and sections available due to enrollment and teacher availability. Therefore, a comprehensive and transdisciplinary lens of climate change should be applied to the curriculum to ensure that learning about climate change was not an optional experience for students. This review needs to look at all subjects and grades and apply a learning progression of climate change learning. Previous learning progressions for climate change have focused on climate change science learning (Breslyn et al., 2017; Parker et al., 2015). However, curricular reform required a transdisciplinary learning progression that addressed scientific, environmental, social, cultural, and economic dimensions, including dimensions of justice and ethics.

In the Canadian curriculum policy context, the shift to concept-based and competency-driven curriculum first initiated by British Columbia and then in Nova Scotia and New Brunswick was an important

step for promoting active learning strategies across K-12 schooling. However, this shift necessitated increased funding in professional development for teachers to shift teaching practices to competency-driven approaches and to link issues like climate change to big idea concepts within the curriculum. Our initial review of the older British Columbia curriculum resulted in more climate change curriculum expectations than the new concept-based and competency-driven curriculum (2016 - 2021). However, in our review, we noted that a teacher with an understanding of climate change could easily make many connections to the big idea concepts in the reformed curriculum, but this was dependent on the teacher's knowledge and not on the explicitness of the curriculum. Ministries of education should continue to move towards concept-based and competency-based curricula approaches while also ensuring there were clear climate change frameworks and professional development programs that supported how teachers could integrate climate change learning to the concepts and competencies within the curriculum.

Climate change curriculum development also requires an action-orientation to learning. In our analysis, only 13% of courses had climate change expectations that focused on climate change learning. If schools were to help improve the quality of climate change education as articulated in Article 12 of the Paris Climate Agreement, this will be a focus area. Support for increased learning about climate change through action has increased from youth advocates like the Climate Education Reform British Columbia. Psychology studies have also shown that engaging in climate action can help reduce levels of climate anxiety (Clayton et al., 2017) and that this engagement taught students how to engage in collective capacity-building community projects while reducing greenhouse gas emissions (Cordero, 2020).

Lastly development of climate change education curriculum needs to follow the substantial evidence-base of accepted science and policy interventions for addressing climate change as recognized in international climate policy (such as most recently in the CoP 26 agreement which acknowledged fossil fuels as primary drivers of climate change. However, very few expectations in Canada acknowledged fossil fuels as primary drivers) and draw upon the expertise of climate leaders with a variety of backgrounds.

Administrative Leadership and Climate Change Education

In some countries, there has been administrative leadership on climate change education. Administrative leadership in Canadian education extends from priorities set out by the ministry of education of each province to individual school boards and their 5-year strategic plans. Responding to the mounting scientific evidence of climate impacts and the global youth climate strikes, administrative leaders in Italy, New Zealand, the state of Islamabad, and New Jersey have mandated climate change education as a mandatory subject. In Canada, the only ministry of education to release a policy statement guiding climate change education is British Columbia to date. From our results, there are examples of climate change expectations within curriculum documents but there is a need for policy directives to guide school boards and schools on responding to the climate crisis and specifically addressing how climate change education should be integrated into teaching through providing frameworks.

As ministries engage in curriculum review processes for climate change, there should be a consultation mechanism specifically focused on youth stakeholders and Indigenous peoples to participate in curriculum development and review processes, given how climate impacts will adversely affect their quality of life in the coming decades.

Limitations of the Study

Through our review of climate change education expectations, there were some limitations that impacted our results. First, our study aimed to provide a comprehensive review of climate change integration in existing school curricula. We analysed most provincial school curricula explicitly stating climate change expectations. A closer review of Quebec should be conducted by educational researchers with greater familiarity of the Quebec education system and policy documents.

Second, this study is prone to curriculum documents in flux as the analysis is limited to existing provincial school curricula (from grade 7 to grade 12) as of the end of 2020. In practice, curriculum documents may be subject to changes and developments. Therefore, policy updates should be reflected in future reviews.

Third, the current study does not address potential gaps that may arise from curriculum policy to

practice. Implementation may be far from expectations, as teachers' perceptions towards policy and curriculum may be influenced by their personal worldviews (Cotton, 2006; Cutter-MacKenzie & Smith, 2003). Future research may involve a holistic analysis of curriculum policy as well as teacher practice. Additionally, research comparing how different groups of teachers with different academic backgrounds form perceptions and attitudes towards climate change curriculum may shed light on strategies relating to professional development, pedagogical practice, and support systems.

Conclusion

If the Canadian K-12 education system intends to be an actor in the global move to meet 1.5 degrees of warming by 2030, there is a critical need for educational leadership within ministries of education to ensure that curriculum is improved when it comes to climate change content. This study highlights the fractured and inconsistent inclusion of climate change expectations as well as the shallowness of most expectations when it comes to actively engaging young learners in climate change education or action within Canadian classrooms. Curriculum reform is but one mechanism and ministries can influence practice through declaring climate emergencies, making policy statements on climate change education, and improving professional development opportunities for teachers. It is important to note that creating urgency about climate change is complex, and while education plays an imperative role, it is recognized that helping address the climate crisis and its impacts requires a whole-society response.

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Appendix A: Bright Spots of Canadian Curriculum Focused on Climate Change

In this section, we highlight some areas of the curriculum that have some strengths and are worth exploring for curriculum developers and policymakers. These small cases synthesize findings from our analyses to highlight some strengths in regional curricula. Some of the bright spots are noted for their coverage of climate change content while others are noted as pedagogic best practice. In the discussion section of the paper, we will come back to the overall need to improve the quantity and quality of climate change education across Canadian curricula and offer substantive climate change education curriculum shifts and suggested processes for climate change curriculum development.

Nunavut: Emphasizing an Indigenous Lens and Framework into Climate Change Science

Nunavut has select courses that the Ministry has chosen to include in their Territory's teaching practice,

alongside many others adapted from Alberta curricula. Various modifications have been made to existing courses from this partnering province to meet students' needs and emphasize an Indigenous lens and reflect Inuit Qaujimajatuqangit (which means "Inuit Traditional knowledge").

For example, the Alberta Grade 10 Science Curriculum was altered under Unit E: Freshwater and Saltwater Systems. In this unit, foundational knowledge questions featured in Nunavut's curriculum include, "How do water, land and climate interact?" and students are asked to investigate and describe the movement of ocean currents and its impact on regional climates. This is taking the Alberta curriculum and modifying it to allow for local and meaningful impacts for students. A course unique to Nunavut (based on Northwest Territories curricula) is the *Experiential Science 10 Education, Culture and Employment* (2006). The course allows for a hands-on learning experience while learning more about climate change. For instance, in *Unit 2: Climatology and Meteorology,* one of the specific learning outcomes includes: "Discussing climate change with local Elders or other subject matter experts, to determine how weather patterns have changed over their lifetime and record the impact of climate change on traditional hunting and gathering activities" (2014). This course also integrates units such as *Ecology of the Land*, which includes learning from hunters and naturalists while being on a field expedition and gaining a better understanding of the circle of life. With a strong emphasis on an Indigenous lens, this can be a powerful climate learning opportunity for all. As Kimmerer (2020) emphasizes, "Action on behalf of life transforms. Because the relationship between self and the world is reciprocal, it is not a question of first getting enlightened or saved and then acting. As we work to heal the earth, the earth heals us".

Manitoba's Comprehensive Climate Change Expectations across Grades 7-12 Social Studies

In Manitoba, the majority of climate change expectations are found in Social Studies rather than in the Sciences (see Figure 1), in complete contrast to other provinces and territories across Canada. Manitoba has a very strong count of climate change related expectations in Social Studies curricula and had the most expectations specifically pertaining to climate change compared to any other Canadian curricula policy.

The Social Sciences curricula has 216 climate change expectations, in which all courses were ranked at least a 2 out of 3. In Grade 7 Social Studies, students begin to delve into critical questions related to food security, climate change, and the global effects of overconsumption. The unit, "People and Places in the World" ranked a 3 out of 3 because it features a culminating learning experience where students apply their knowledge and evaluate themselves as ecologically and socially responsible citizens, answering the question: "what can you do?". This ultimately extends learning from the basics about climate change to real action opportunities for students. Teachers can also implement project-based climate change learning to allow students to further act on their knowledge acquisition.

Another exemplary Social Studies course that ranked at a 2.5 is Grade 12 Global Issues (elective). This course uses the UN Sustainable Development Goals (SDGs) to address critical topics such as climate change, economic inequality, innovation, sustainable consumption, and justice. Students analyze adaptation and mitigation approaches to climate change, and are asked critical analysis questions such as: *1) How does the media influence the way we see climate change? 2) Who is affected most by changing weather patterns in Canada and globally? 3)What actions can we take now to reduce the risk posed by changing climate conditions and sea-level rise?* Examples of inspiring individuals who have taken action against climate change are also discussed, thus allowing learners to see what climate action work is already being done locally and globally.

British Columbia's Concept-based Competency-Driven Approach

In British Columbia, climate change was found in the sciences more than in the geography curriculum. British Columbia has recently updated its entire curriculum, moving towards a transdisciplinary and competency-based approach, and leaving room for each teacher to elaborate on specific aspects of "key themes" in the curriculum. This curriculum shift is also occurring in Nova Scotia and New Brunswick. With the move from content descriptors to competency-based approaches, has resulted in the curriculum having fewer explicit mentions of climate change. However, this approach to teaching is in better alignment with best practices of climate change education but requires teachers to have access to professional

development.

In British Columbia, there is the "core curriculum" and "elaborations," which are suggested topics, teacher prompts, and definitions that could assist the teacher. These elaborations were not included in the search result but were taken into consideration for the ranking process. Specifically, there was an evaluation of whether there was an opportunity for teachers to go above and beyond and integrate climate change to their discretion. For example, in Grade 9 Science, climate change is part of the core content, examining the evidence of climate change over geological time and the recent impacts of humans, physical records and local First Peoples knowledge on climate change. Climate change can also be included in the "Elaborations" in some courses of the curriculum documents where climate change is mentioned.

British Columbia had 63% of all climate change search results in mandatory courses. However, looking specifically at the Science breakdown, 17 out of 19 expectations in science are only found in elective courses, which poses a concern. When analyzing the depth of these search results through the ranking system, the focus on the core courses was on climate science and knowledge, and less on climate action, project-based, or application of student learning. While in grades 7, 8, 9, 10, this can be beneficial to develop foundational knowledge, this does not allow further communication and application opportunities. In the senior grades, especially in Science, Environmental Science and Specialized Science courses, students review the core concepts of changes to climate systems, and impacts of global warming. However, throughout the elaborations of Environmental Science, there is an excellent framework for analyzing, interpreting and applying the data and knowledge students have learned. Students are given the opportunity to apply their knowledge to create change in their local communities and strategies for positive change. An example of this is an inquiry project to "demonstrate to your local city council the need to ban plastic bag use in your community." (BC Ministry of Education, 2018). These types of inquiries allow the course to reach a level 3 in ranking.

Ontario's Cross-Curricular Approach and Mandatory Climate Change Unit

Our review of the Ontario curriculum documents showed that overall, there are more climate change expectations in Social Studies (68) than in the Sciences (42). In Ontario there is a mandatory grade 10 Science course that accounts for 33 of the 42 climate change expectations found in the curriculum. We are highlighting Ontario because it has a mandatory climate change unit and because expectations occur across subject areas, in a cross-curricular approach. Areas for improvement are to increase the number of expectations into mandatory courses, for example, 82% of climate change expectations in Social Studies were found in Senior (Grade 11 and 12) elective courses. The mandatory Grade 10 Science course was ranked 2.5 out of 3, as the unit focuses on students developing an understanding of the effects of human activity on climate change, and the effects of climate change on living things and natural systems.

In terms of elective courses, climate change is mentioned in Grade 10 Civics & Careers, Grade 12 Economics, Grade 11 Gender Studies, Grade 11 History, Grade 12 Law & Legal Studies and Grade 12 Politics. While these courses are only ranked at level 1, they offer opportunity for climate change extensions using a transdisciplinary and competency-based approach. In elective Grade 10 Civics and Careers or Grade 12 International Law, students are able to examine the Canadian perspectives on federal elections and international treaties with inquiry questions including, "How does the Canadian perspective on issues relating to climate change differ from that of other countries?" (Ontario Ministry of Education, 2015). These critical questions enhance student knowledge, skills and understanding while motivating them to learn through stimulating, interconnected topics.

New Brunswick: Teacher-Student Co-developed Courses

A particularly distinctive approach to curriculum structure is one that New Brunswick has taken in implementing place-based education as a foundation for course offerings and teaching strategies. As mentioned above in British Columbia's 'bright spot' explanation, New Brunswick is in the process of updating its curriculum documents, changing from content descriptors to competency-based approaches, which in turn, means fewer explicit mentions of climate change. Through analyzing Ministry documents from consultants, courses offered but not explicitly mentioned on the Ministry website are Locally Developed or Locally Created Courses. These courses are unique because they are led by teachers and co-created with students to address a meaningful topic in their local communities. These allow for inter-

disciplinary and cross-curricular coverage of concepts, themes and issues. Often, they are addressing a local issue by looking at action-based solutions. Examples in the past have included climate change integration within the Sciences, for example, investigating the growing tick population and the rise of cases of Lyme disease. Giving both teachers and students choice and the creative freedom to create a course on a topic students are passionate about allows for the course to reach a Level 3 of the ranking system. This is because students and educators alike are able to meaningfully act on climate change learning, communicate their understanding to the broader community, and engage in project-based climate change learning, which are all indicators of best practice.

Reference-worthy Elective Courses

Nova Scotia Mi'kmaw Studies

Mi'kmaw Studies is based on a holistic perspective that integrates the past, present, and future. The course incorporates an inquiry-based approach and examines broad concepts such as governance, culture, spirituality, education, and social justice. Students analyze historical and contemporary Mi'kmaw issues, which enable thems to achieve a greater understanding of, and respect for, both Mi'kmaw society and Mi'kmaw contributions to Canadian society. The Grade 11 Mi'kmaw course celebrates and educates students about Indigenous history and Indigenous world views of the natural world. Students identify significant factors that influence the interaction of the physical and human environments and the impact on their environments, focusing specifically on the Atlantic region. Through an Indigenous lens, students look at the uniqueness and connectedness of a particular location, scaffolding the ability to look at the perspective of a place and how they may or may not identify with a sense of place. This is a critical theme in the "Interactions and Associations'' framework within the course, which emphasizes the question, "How am I connected to the First Peoples of Nova Scotia?". As a result, students can become more informed, active citizens who have a holistic understanding of the relationship between Indigenous people and Indigenous world views in Nova Scotia and Canada.

Saskatchewan Horticulture, Energy and Mines, and Forestry

Saskatchewan has a unique subsection of its curriculum documents titled "Practical & Applied Arts." The selection of courses that are offered to students focus on developing personal skills, gaining entry-level employment skills, pursuing post-secondary education and training or apprenticing in the trades. For instance, three courses that discussed climate change were the Horticulture Studies, Energy and Mines and Forestry courses. These courses investigated the implications of Saskatchewan's current status and impact of climate change in the industry in their respective ways. Within the Energy and Mines curriculum, students explore 'sustainable' levels of energy use in the context of climate change; however, students are also asked to find evidence that carbon dioxide gas produced by coal-burning contributes to the build-up of greenhouse gases and climate change. Asking students to focus on this is out of alignment with the consensus on anthropogenic climate change and instead students should be taught about the consensus and rigour of the scientific evidence. Debates can focus on how to mitigate or adapt to greenhouse gas emissions but not debate the scientific evidence. In *Horticulture Studies*, students explore how climate change can significantly impact soil use and conservation. Lastly, in *Forestry*, students investigate the factors that affect forest health and decline and how climate change has impacted them. Taken together, these experiential courses provide contextual information about how climate change relates to occupations. This is noteworthy and an area to improve across subject areas to help orient learners towards considering how climate change will impact economic and job sectors as well as industry growth is expected due to climate-related jobs.

Appendix B: Detailed Climate Change Education Expectations Breakdown by Province, Grade, and Course

Detailed Climate Change Education Expectations Breakdown by Province, Grade, and Course
*explicit mentions of "climate change"

Province	Regional Totals		
	Science	Social Studies	Other
British Columbia	19	27	0
Alberta	25	0	0
Saskatchewan	33	11	8
Manitoba	20	216	0
Ontario	42	60	7
Quebec	1	0	0
PEI	64	43	0
Nova Scotia	96	2	0
New Brunswick	24	7	0
Newfoundland	118	36	0
Yukon (BC)	22	10	0
NWT (Alberta)	59	5	0
Nunavut (Alberta)	59	5	0

Detailed Regional Breakdown

British Columbia (Yukon)

Science	Mandatory	Grade 7		2
		Grade 8		0
		Grade 9		0
		Grade 10		0
	Elective	Grade 11 Life Sciences		0
		Grade 11 Earth Sciences		3
		Grade 11 Chemistry		1
		Grade 11 Science for Citizens		3
		Grade 11 Enviro Sciences		1
		Grade 12 Enviro Sciences		7
		Grade 12 Chemistry		0
		Grade 12 Specialized Science		2
			Science Total:	**19**
Social Studies	Mandatory	Grade 7		0
		Grade 8		0
		Grade 9		0
		Grade 10		0
	Elective	Grade 11 Social Studies		5
		Studies		0
		Grade 12 Human Geography		1

		Grade 12 Physical Geography	1
		Grade 12 Urban Studies	1
			Social Studies Total: 27
Alberta (NWT, Nunavut)			
Science	Mandatory		
		Grade 7	0
		Grade 8	0
		Grade 9	0
		Grade 10	19= 17 (Science 10) + 2 (Sc 19
	Elective	Grade 10 Knowledge & Employability	1
		Grade 11 General Science	2
		Grade 12 Chemistry	1
		Grade 12 General Science	2
			Science Total: 25
	Mandatory	Grade 7	0
Social Studies		Grade 8	0
		Grade 9	0
		Grade 10	0
			Social Studies Total: 0
Saskatchewan			
Science	Mandatory		
		Grade 7	1
		Grade 8	1
		Grade 9	1
		Grade 10	7
	Elective	Grade 11 Physical Science	1
		Grade 11 Environmental Science	18
		Grade 12 Earth Science	2
		Grade 12 Chemistry	1
		Grade 12 Biology	1
			Science Total: 33
	Mandatory	Grade 7	3

Social Studies		Grade 8	0
		Grade 9	0
		Grade 10	0
	Electives	Grade 11 &12- Horticulture, Energy and Mines, Forestry	8
			Social Studies Total: 11
Manitoba			
Science	Mandatory		
		Grade 7	0
		Grade 8	0
		Grade 9	0
		Grade 10	4
	Elective	Grade 11 Current Topics in Science	6
		Grade 11 Chemistry	10
			Science Total: 20
		Grade 12 Chemistry	3
	Mandatory	Grade 7	29
Social Studies		Grade 8	0
		Grade 9	3
		Grade 10	29
	Elective	Grade 12 Global Issues	155
			Social Studies Total: 216
Ontario			
Science	Mandatory		
		Grade 7	0
		Grade 8	1
		Grade 9	0
		Grade 10	33
	Elective	Grade 11 Biology	2
		Grade 11 Environmental Science	3
		Grade 12 Earth and Space Science	2
		Grade 12 Biology	0
		Grade 12 Science	1
			Science Total: 42
	Mandatory	Grade 7	8
Social Studies		Grade 8	1
		Grade 9 Geography	2
		Grade 10	1

	Elective	Grade 11 Forces of Nature: Physical Processes and Disasters	13
		Grade 11 Travel and Tourism: A Geographic Perspective	5
		Grade 11 Regional Geography	15
		Grade 11 Introduction to Spatial Technologies	1
		Grade 12 The Environment and Resource Management	5
		Grade 12 Spatial Technologies	8
		Grade 12 Living in a Sustainable World	4
		Grade 12 World Geography: Urban Patterns and Population Issues	1
		Grade 12 World Issues: A Geographic Analysis	4
		Social Studies Total:	**60**
		Grade 12 Legal Studies	1
		Grade 12 Canadian and International Politics	4
		Grade 11 Politics in Action: Making Change	2
		Other:	**7**
	Mandatory		
Quebec		Grade 7	0
Science		Grade 8	0
		Grade 9	0
		Grade 10	0
	Elective		
		Grade 11 Science & Technology	1
		Science Total:	**1**
	Mandatory	Grade 7	0
Social Studies		Grade 8	0
		Grade 9	0
		Grade 10	0
	Elective		
		Social Studies Total:	**0**
Nova Scotia			
Science	Mandatory		
		Grade 7	9
		Grade 8	85

		Grade 9	0
		Grade 10	2
	Elective		
			Science Total: 96
	Mandatory	Grade 7	0
Social Studies		Grade 8	0
		Grade 9	0
		Grade 10	0
	Elective	Grade 12 Global Geography	2
			Social Studies Total: 2
New Brunswick			
Science	Mandatory		
		Grade 7	0
		Grade 8	1
		Grade 9	0
		Grade 10	1
	Elective	Grade 11 Intro to Environmental Science	14
		Grade 11 Biology	0
		Grade 12 Advanced Environmental Science	8
		Grade 12 Biology	0
			Science Total: 24
	Mandatory	Grade 7	0
Social Studies		Grade 8	2
		Grade 9	1
		Grade 10	0
	Elective	Grade 11 Physcial Geography	3
		Grade 12 World Issues	1
			Social Studies Total: 7
PEI			
Science	Mandatory		
		Grade 7	2
		Grade 8	2
		Grade 9	11
		Grade 10	9
	Elective	Grade 11 Biology	1
		Grade 11 Physics	1
		Grade 12 Physics	1
		Grade 12 Human Biology	1
		Grade 12 Biology	1
		Grade 12 Animal Science	1

		Grade 12 Agriscience	1
		Grade 12 Environmental Science	33
			Science Total: 64
Social Studies	Mandatory	Grade 7	0
		Grade 8	1
		Grade 9	9
		Grade 10	17
	Elective	Grade 11 World Geography	8
		Grade 12 Global Issues	6
		Grade 12 Intro to Economics	2
			Social Studies Total: 43
Newfoundland			
Science	Mandatory		
		Grade 7	0
		Grade 8	4
		Grade 9	0
		Grade 10	34
	Elective	Grade 11 Life Sciences	23
		Grade 11 Earth Systems	3
		Grade 11 Chemistry	1
		Grade 11 Science for Citizens	
		Grade 11 Enviro Sciences	53
		Grade 12 Enviro Sciences	
		Grade 12 Chemistry	
		Grade 12 Specialized Science	
			Science Total: 118
	Mandatory	Grade 7	0
Social Studies		Grade 8	0
		Grade 9	0
		Grade 10	0
	Elective	Grade 11 Social Studies	
		Grade 12 Comparative IndigenousStudies	
		Grade 12 Human Geography	
		Grade 12 Physical Geography	
		Grade 12 Social Justice Grade 12 Urban Studies Grade 12 Physical GeographyGrade 12 Geology	
		Grade 12 Social Studies	36
			Social Studies Total: 36

Nunavut			
NWT (**See Alberta with these exceptions)			
	Elective	Grade 10, 11, 12 Experiential Science	**19**
NWT (**See Alberta with these exceptions)			
	Mandatory	Grade 10 Science (Strand: Iqqaqqaukkaringniq)	28
	Elective	Grade 11 Science (Strand: Iqqaqqaukkaringniq)	4
		Grade 12 Science (Strand: Iqqaqqaukkaringniq)	4
			Science Total: 55