

# **What is Excellent Climate Change Education?**



**A guidebook  
based on peer-reviewed research  
and practitioner best practices**

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## FOREWORD

*We're the last generation who have the chance to combat climate change. If we don't do that, then nothing else matters.*

*Steve Lee, age 25 - Foundation for Environmental Stewardship*

*When it comes to climate change, the antidote to despair is action.*

*Leah Buchanan, student at Queen Elizabeth High School in Edmonton, and former Chair of Alberta Climate Leadership Youth Network*

**About us.** The Alberta Council for Environmental Education (ACEE) works collaboratively to advance environmental education and energy education, which of course includes topics such as climate education. A non-profit organization with charitable status, we have five staff: Executive Director Gareth Thomson, Education Director Kathy Worobec, Program Director Christina Pickles, Youth Coordinator Laura Hughes, and Fund Development Manager Diane Kashuba.

**About climate change education.** Climate change is widely understood by scientists, decision-makers, industry leaders and others to be one of the greatest challenges facing our world – yet many teachers have told us that there is not enough education on this topic in Alberta.

This is perplexing – but we get it. The research outlined below tells us that climate change can be discouraging, and scary, for students. Teachers care deeply about their students, and – even in the rare event that this topic is in their curriculum – may underemphasize this topic to avoid bringing distress into students' lives. Other pitfalls abound: we know of teachers who unwittingly stirred up controversy by painting a picture of "industry versus environment," creating some unwelcome conversations between parents, teachers, and administrators. Climate change education in a province with a strong oil and gas economy is possible – but it must be done well. Energy education and related student projects are helpful but this is a very rapidly growing and changing field that challenges even industry experts to keep up – and we all know about the huge workload borne by classroom teachers.

**Climate change education is not easy, but it can be done. We hope that this document helps 'show a way forward.'**

We believe that we can – and must – build climate education competence throughout the education system.

"Teaching about climate change is a test of the maturity and sophistication of ... education. [It demands] that teachers and curriculum developers apply the very best approaches to developing student understanding, reasoning... and conceptual finesse... There is good news and bad news about education that addresses global climate change. The bad news is that the topic is complex and challenging. The good news is *also* that it is complex and challenging."<sup>1</sup> This complexity can fuel creativity, problem solving and

<sup>1</sup> From "The Educational Challenges: A Framework for teaching about climate change," Milton McLaren and William Hammond. In "Teaching about climate change: cool schools tackled global warming," edited by Tim Grant and Gail Littlejohn, 2008.

collaboration; and it supports cross-curriculum teaching, school wide projects and inquiry. We can and must dive in and embrace the complexity.

**Who is this for?** We wrote this guidebook to support the work of classroom teachers **and** those who support K-12 student learning. There are at least a hundred agencies in Alberta who work to support student learning around environment or energy topics. We hope they'll find value here. There are also many organizations supporting classroom education (whose mandates are outside of these topics), who have been mobilized by the threats of climate change. We believe this guidebook will help them map their way forward, as well. There are also local organizations who have capacity for smaller-scale communication, or develop communication materials or outreach programs aimed at public audiences: religious organizations, groups working on social justice or welfare issues, economic development groups, etc. - we hope such groups may also find this helpful.

**About this document.** This work seeks to help answer the question "What is excellent climate change education?" To do this we've pulled from several lines of evidence:

- **Peer-reviewed and refereed academic articles.** We're proud that we were able to review and summarize over 140 such articles in this document. We have focused our review on recently published articles, and also used literature reviews or 'meta-studies' that summarize research findings. We list these articles along with key findings in a separate section.
- **Non-academic publications from governments, NGO's, etc.** Appendix A collates and briefly describes some very helpful resources, including K-12 teaching resources.
- **Practitioner Best Practices.** We are privileged to know and work with many talented professionals who work in this area, and are indebted to them for their contributions, which we have tried to capture.

To develop the current draft, we...

- Recruited Lakehead University graduate student Nathan Skrzypek who gathered and analysed the peer-reviewed research found in Appendix A, and took a first cut at identifying key findings.
- Leveraged ACEE staff experience in energy and environmental education: we took Nathan's work, reviewed helpful non-academic work, and created the first draft.
- ACEE reached out a handful of thoughtful colleagues with deep knowledge in this area, who were kind enough to review this first draft. We have done our best to embed their helpful feedback and suggestions into this current draft. We are indebted to the following:

Amber Bennet  
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Dr. Connie Russell

#### **When it comes to articulating 'What is Excellent Climate Change Education' – have we nailed it?**

Absolutely not. We are committed to the continuous improvement of this document, and the next step falls to you! We welcome your constructive suggestions for improvement; please send those anytime to ACEE Education Director Kathy Worobec, at [Kathy@abcee.org](mailto:Kathy@abcee.org).

## INTRODUCTION

This document is meant as a starting point, to spark your thinking on how best you can incorporate climate change into your education and outreach programs. Based on the current peer-reviewed research and other findings described in this document, we respectfully suggest the following guidelines for excellent Climate Change education:

1. Framing is everything
2. Remember the audience
3. Action oriented
4. Go beyond science
5. Curriculum connected
6. Evaluate

This document also includes an extensive reference and resource section, allowing you to dive deeper as you begin this important work.

## FRAMING IS EVERYTHING

Framing focuses on HOW we present information. Setting a relevant and positive context can be just as important as the actual information we present. Climate change can be framed in many ways: as a public health issue, as social and economic sustainability, as an economic opportunity, or as a chance for students to build skills that can help them get jobs in a low carbon future.

### **Focus on the ‘solution’ space versus the ‘problem’ space**

Gordon Lambert asserts that the topic of climate change contains two spaces—the problem space, and the solution space.<sup>2</sup> Educators must spend as much time as possible in the solutions space. The focus of climate change education should be on solutions – and more specifically on concrete actions that can be taken by the individual students. Climate change education has been shown to be more effective if the focus is on individual empowerment and positive local action being taken to promote a sense of hope in students. Hope is an important precursor to action.

The problem space is an inherently negative space. The 'doom and gloom' messaging that has been commonly associated with climate change has not spurred large-scale environmental action amongst school-aged children. Research tells us that focusing on problems can foster negative feelings of helplessness, inadequacy, and guilt. This is not only unfair for the students, but unproductive for the environment and environmentally responsible behaviour change.

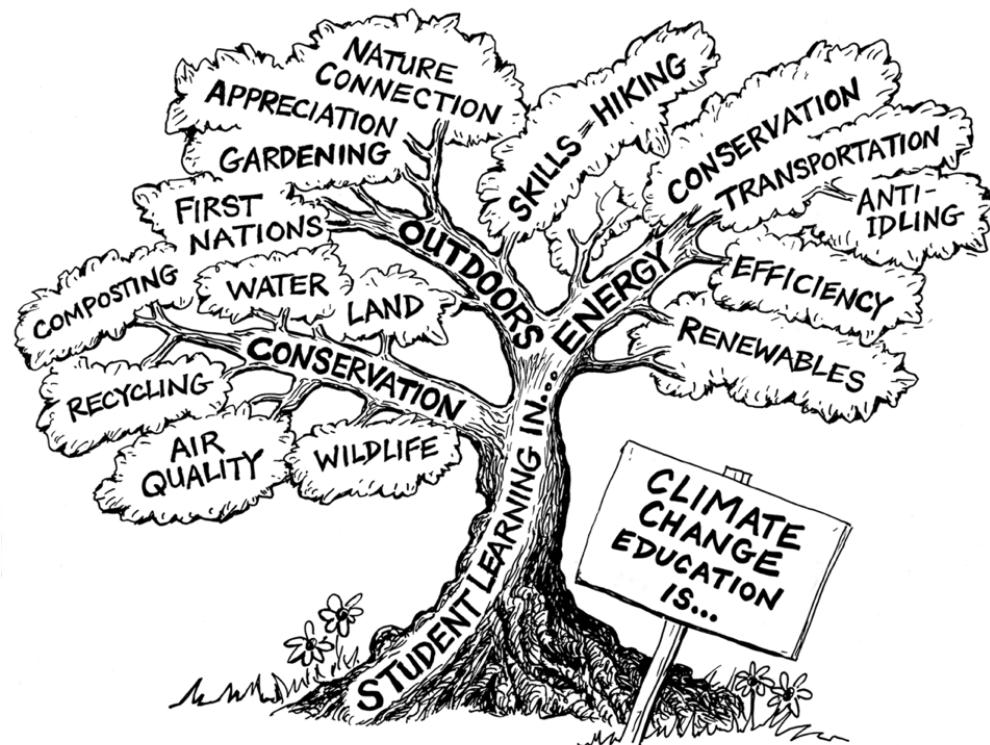
**Frame climate action as part of a positive narrative around shared identity and pride in Albertans.** Alberta is widely recognized as having benefited from a carbon intensive economy and many Albertan's take pride in their history. There is no need to demonize the past, and there are many positive attributes from the past that provide confidence for the future and reinforce our identity. George Marshall (see section below) visited Alberta in late September 2017 and during a series of workshops he 'surfaced' narratives centered around identity and values in his effort to position climate action in a positive and productive manner:

- We are proud of the people in the oil, gas and coal industries who contribute to our prosperity and way of life...

<sup>2</sup> <http://lowcarbonlinks.com/climate-change-framing-matters/>

- Alberta was built on natural resources and energy, and we are rich in natural resources for new forms of clean energy...
- Coping with climate change and changing to new energy will not be easy but we can do it because Albertans are resilient, hard-working, innovative, and resourceful..."

**Climate change education means student learning in energy, conservation, and the outdoors.** In our work to engage Alberta agencies and teachers in this topic, the Alberta Council for Environmental Education developed the following to help frame climate change education. One benefit of this image is that it demonstrates that most Alberta teachers can contribute to climate change education in their own way, in all subjects and at all grades. Teachers and, indeed, the Education Minister have told us that they like this model:



This image proposes three areas of learning for climate change education that involves student learning in energy, outdoors, and conservation:

- **Student learning in energy** probably creates the best “line of sight” to greenhouse gas reductions - a key action in climate change education – as students learning in energy can readily translate into student, school and family activities that reduce the consumption of greenhouse gases.
- **Student learning in conservation** captures many of the conventional environmental topics covered by teachers
- **Student learning in the outdoors** emphasizes the importance of nature connection and nature appreciation, offering a key way in which to help students care and dramatically increasing the possibility that students will act.

**Four themes of effective climate change education.** Monroe et al. (2017) conducted a systemic review of effective climate change education strategies and identified the following four themes of effective climate change education:

- Engaging in deliberative discussions
- Interacting with scientists
- Addressing misconceptions
- Implementing school and community projects

**Climate Change – what's in a word?** McKeown and Hopkins in a 2010 Green Teacher article define climate change education by looking at the two words: **Climate** focuses on the science behind climate change and address the weather and climate systems and could also include the impacts on the natural systems. **Change** is where they suggest it gets interesting as it incorporates the social and humanities aspects of education. They suggest we just consider teaching ABOUT change and FOR change and propose 6 steps to do this: issues analysis, community and personal decision making, political processes, social justice, inter-cultural sensitivity and competence and behaviour change.

## REMEMBER THE AUDIENCE

**'No tragedies before Grade 4'. Programs should be developmentally appropriate.** The abilities and competencies of children and youth change as they grow and programming needs to reflect that. Dr. David Sobel said: "*No tragedies before Grade 4... If we want children to flourish, we need to give them time to connect with nature and love the Earth before we ask them to save it.*" All students should engage in critical thinking and learning about how Earth's natural systems work. Supporting students with age appropriate action projects is also key. Younger children should engage in projects that focus on their local communities, so long as they understand *why* they are doing these sorts of things; while students in high school should be encouraged to engage in values clarification, and be invited to engage in a variety of personal and public action projects.

**Support teachers.** The old saying 'You can give a someone a fish for a day – or you can teach them how to fish' applies here. Excellent environmental education programs provide learning experiences for teachers as well as students. The future is galloping towards us at an increasingly fast rate these days, and teachers need our support when it comes to providing timely teaching resources or information about such things as new clean energy technologies. Teachers want to engage their students in current, meaningful and relevant discussions. They deserve the professional learning that enables them to do this.

## PROGRAM DESIGN ELEMENTS

Below we propose four main program design elements of excellent climate change education: Action oriented, go beyond science, curriculum connected, and evaluation.

### ACTION ORIENTED

We mustn't prescribe what action students should take – but we must encourage them to do something. As Wangari Maathi said: "*Without action, environmental education is just talking, talking, talking.*" Here is another quote from Dr. David Orr: "*Hope is a verb with its sleeves rolled up.*" Research confirms that those students who consider themselves to be environmental stewards because they have actually DONE something are more hopeful about the environment - they know they can make a difference!

**Learners act because of how they feel, not what they know.** Programs should help students feel that their action can make a difference, stressing positive elements and weaving in 'Yes, we can!' style messages. Teachers generally bring a positive and encouraging outlook to their students, and programs should find a way to build upon this. In this area feelings are important and need to be acknowledged, so programs should address the affective as well as the cognitive domain, building in ways for teachers and students to 'go there' when it comes to unpacking student feelings.

**Action on climate change must be both personal and public.** Al Gore said it best: "It is not enough to change light bulbs – we must change public policy." It is powerful when we make personal commitments to action but, given the scope of the climate challenge, it is essential that education programs support and promote change in the public arena, orienting students to opportunities to engage in citizenship action and democratic processes that can change policies and legislation. Students should be asked to consider their personal lifestyle changes AND be given a chance to change the world in other ways, thinking about the social, economic and political systems in which they live, and considering how changes to these systems might be better for their future and better for the planet.

**Give students action skills.** Students need to learn skills like identifying an issue, mobilizing their community, finding resources and developing partnerships to name a few in order to take effective action, and programs should give learners a chance to practice and master these skills. Action skills can also include career information that can help them see how they will be able to make positive change and action once they are in the workforce.

**Get outdoors.** What do you remember best about your own K-12 journey? We bet that chief among these memories are engaging outdoor experiences, which form valuable 'velcro' onto which complex concepts can be more readily attached. Students don't need to go far to be immersed in nature, building a relationship with 'nearby nature' in local parks and schoolyards is the best place to start. From David Sobel, educational researcher and writer: "Wet sneakers and muddy clothes are prerequisites for understanding the water cycle."

**Make climate change 'us, here and now'; not 'them, there and then.'** If problems are perceived to be occurring *down the road*, then people will consider changing their behaviours *down the road* and not now. This global issue must be taught in a local way. The image of a polar bear standing woefully on melting ice makes people feel as though the problem is elsewhere, and is caused by (and should be solved by) other people, leading to a feeling of being disconnected from the problem and solutions. Instead, it has been shown that education relating to climate change is more effective when local examples of the effects of climate change are used, perhaps using place-based

education. For example, discussions could revolve around the 2013 flooding in Alberta, immediate impacts on farmers as seasons become hotter and drier, or how forest fires are now viewed to be the ‘new normal’ in Alberta and British Columbia.

## GO BEYOND SCIENCE

It didn’t work. For decades, scientists, educators, and non-governmental agencies provided people with information about climate change in the hope of convincing them that human-caused carbon emissions lead to climate change, and that they need to take action. But it didn’t work – as we now know, there is a disconnect between environmental knowledge vs. environmentally conscious behaviour. Knowing about climate change is not enough to lead to environmentally responsible behaviour. We need to do more than that...

**Construct a compelling narrative leading to a positive resolution – describe the world we want to see.** Maintain a focus on the positive outcomes that will result from what we do today, showing how student action helps deliver on a positive vision of the future.

**Place-based.** We care deeply about the places and spaces we work and play in every day. Students need to examine climate change impacts close to home by learning about and observing their schoolyards, neighborhoods and communities. Action projects should focus on school and community based projects, students’ ‘local places’ where they can see the direct result of their actions.

**Responsible climate change education helps students learn HOW to think, not what to think.** Good programs encourage learners to consider the many sides of an issue, think critically and creatively about the information presented, and come to a conclusion that is based on their own values. We all have our biases, and understanding them helps us be better problem solvers.

**Avoid Fear.** Scare tactics are not effective in education. We want students to act out of a sense of empowerment, hope, and responsibility. Those feelings are mutually exclusive with fear. Fear can lead to senses of dread, powerlessness, and paralysis.

**Climate change is different from other environmental issues, so be prepared.** Significant efforts have gone into misinformation relating to understanding climate change for the general public. It is important for educators to be aware of false beliefs when it comes to climate change, to avoid being caught off guard and having their efforts derailed.

**Climate change is a matter of social but not scientific controversy.** When teaching climate change:

- Present climate change as a scientific fact. Be prepared to cite the consensus in the scientific community. Multiple studies published in peer-reviewed scientific journals show that 97 per cent or more of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities (NASA, 2016). Internationally, governments have created a series of agreements such as the Paris Accord that acknowledge climate change as a scientific fact.
- Do not debate whether or not climate change is happening. Instead, have debates around how communities can best address climate change, or, if appropriate, discuss the issue of why climate change is socially controversial.

- Call upon other lines of evidence. For example, Appendix C contains the climate policy statements of many leading energy companies.
- Be respectful of students. They may have heard mixed messages about climate change and can have a very difficult time figuring out what to believe.

## CURRICULUM CONNECTED

**Connect to curriculum – and competencies.** Teachers are required to design learning experiences for their students that address the learning outcomes outlined in provincial curriculum (programs of study); your program MUST clearly show connections to these programs of study if they are to be widely used. Alberta's curriculum development process means that this is a bit of a moving target - but the current curriculum will remain in effect until future curriculum is approved by the Minister. At the time of writing the provincial government has set no date to implement new curricula – [check here for updates](#). For the time being, we recommend you show connections to existing curriculum, AND show how your program helps support students in developing and applying the competencies outlined in the 2013 [Ministerial Order on Student Learning](#).

**Cross-curricular.** We believe that climate change education belongs in many subject areas, and that a cross-curricular approach to the topic is best: it should include science concepts, but expand to other content areas (social studies, language arts, math, careers education etc.).

**Encourage systems thinking.** Teaching students about climate change can help to develop a more well-rounded understanding of its causes and implications. For example, having an understanding of human history can help students understand how the various agricultural, economic, and technological revolutions have created entrenched structures that are currently in place. Systems thinking is an essential student competence: for example, a student action project will be most effective when students understand the complex system within which their proposed solutions must take place.

**Connect the dots between Climate Change Mitigation, Adaptation, and Resilience.** The terms 'mitigation' and 'adaptation' refer to two paths for dealing with climate change. **Mitigation** deals with the causes of climate change and works to reduce human-made effects on the climate system. In contrast, **adaptation** suggests changes that should be made to prepare for and buffer the effects of climate change, thereby reducing the vulnerability of communities and ecosystems. By adapting to cope with effects of climate change we build up climate **resilience**. Climate change mitigation and adaptation are interdependent, and mitigation strategies may also include elements that deal with adaptation at the same time.<sup>37</sup>

## EVALUATION

**Program evaluation can inform improvement of the program– AND highlight student accomplishments, AND provide much-needed profile.** Those who support the myriad of programs available in our province want to know

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<sup>37</sup> <http://www.actiononclimate.today/act-on-information/mitigation-adaptation-and-resilience-climate-terminology-explained/>

what happened – AND good education providers are eager to find out too, so they can plough their learning back into the program. Give teachers student assessment tools that they can use to assess student learning – then circle back to the teacher as part of your work to assess how well your program is working. Students should celebrate their enviro-accomplishments, and some clever groups manage to weave this into both their program and evaluation.

#### **Always test your messages (with both supported and opponent audiences)**

There have been many excellent programs whose launch was unsuccessful for one simple reason: they did not check to see how their message would be interpreted and received by their target audience, especially for those with different views. If you invite in these fresh sets of eyes as you build your program, you can make corrections before you launch your work.

### **SUMMARY OF RECENTLY PUBLISHED LITERATURE REVIEWS**

We analyzed five literature reviews, which provide a rich basis for our key findings and effective approaches.

*Li, Christine & Monroe, Martha. (2017). Exploring the essential psychological factors in fostering hope concerning climate change. Environmental Education Research. 1-19.*

- Hopefulness has been found to be an important psychological precursor for action, and should be nurtured with the belief that changes at the personal and local level can have a significant impact.
- The authors suggested educators use imagery that supports this view by showing people helping at the "individual and community level in addition to providing climate science information".

*Wibeck, Victoria. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. Environmental Education Research. 20.* The author found:

- Although fear-based messaging is common, it is likely to promote feelings of apathy and hopelessness.
- When communicating about climate change educators should consider how their messages will be interpreted and how that interpretation will be affected by students' "values, attitudes, and beliefs, particularly towards a specific issue or a site-specific resource".
- There is a general shift away from public understanding towards public engagement in climate change.
- Given "climate fatigue" of the media and public, it may be worthwhile to consider ways to reframe the climate change messaging. For example, consider teaching about climate change when talking about public health, sustainable development, or economic sustainability.
- Thought should also be given to what mitigation and adaption strategies that would be expected of the target audience as well.

*Hermans, Mikaela & Korhonen, Johan. (2017). Ninth graders and climate change: Attitudes towards consequences, views on mitigation, and predictors of willingness to act. International Research in Geographical and Environmental Education. 1-17.*

- Secondary school students in Western countries generally appear to "experience climate change as a risk", mitigation to climate change is important, international cooperation to be *most significant*, and that individuals should contribute as well.
- Students were generally found to be most willing to take mitigative action that required limited effort on their part, and least willing to take action if it presented a significant inconvenience for them or their lifestyle. This was true regardless of attitudes related to the perception of climate change as a risk or the belief in the importance of mitigation. This point is further reinforced with the following finding:

- "An understanding of the background of climate change and perspectives on the consequences of climate change for biodiversity, human health and their own living conditions did not significantly predict students' willingness to act."
- The authors encouraged an approach to education that is **action-oriented with a focus on active participation and cooperation**. Also, given that environmental connection is a significant predictor of an individual's willingness to act, **climate change education should foster environmental connection in learners**. They encouraged this approach especially for learners in their late childhood and early adolescence.

*Monroe, Martha & R. Plate, Richard & Oxarart, Annie & Bowers, Alison & A. Chaves, Willandia. (2017). Identifying effective climate change education strategies: a systematic review of the research. Environmental Education Research. 1-22.*

The authors identified four themes:

1. Engaging in deliberative discussions,
  2. Interacting with scientists,
  3. Addressing misconceptions, and
  4. Implementing school or community projects.
- The challenge of climate changes education suggests that effective education - experiential learning and social-constructivism – may not be sufficient to explore science-based yet culturally influenced issues such as climate change. These may need to be combined in new ways that help students explore their own assumptions and perspectives in the context of sound science and others' perspectives on the issue.

*Roychoudhury, Anita; Shepardson, Daniel P.; Hirsch, Andrew; Niyogi, Devdutta; Mehta, Jignesh; Top, Sara. (2017). The Need to Introduce System Thinking in Teaching Climate Change. Science Educator. 2-25.*

- The authors found that there should be a focus on the understanding of environmental, climate, and weather **systems** when talking about climate change as opposed to focusing narrowly on "changes and their causes."

## KEY FINDINGS FROM ACADEMIC RESEARCH

Below are some of the overall findings and key themes that we have identified from the literature we reviewed. Our focus was to capture a 'snapshot' from the current research to provide guidance on effective climate change education. Each of these findings lists some specific references for readers who may wish to learn more about any of the key findings.

The following themes emerged as the most common recommendations for climate change education and outreach.

## FRAMING

**It is important to consider your target audience when creating climate change communications, and consider how your messages will be interpreted. "Effective environmental education and interpretation relies explicitly**

**on understanding the audiences' values, attitudes, and beliefs, particularly towards a specific issue or a site-specific resource".<sup>4</sup>**

For further reading about this theme, consider:

- Linn, Marcia C., and Sherry Hsi. 2000. Computers, Teachers, Peers: Science Learning Partners. Mahwah, NJ: Erlbaum.
- Hudson, Stewart J. 2001. "Challenges for Environmental Education: Issues and Ideas for the 21st Century." BioScience 51 (4): 283–288.
- Wibeck, Victoria. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. *Environmental Education Research*. 20.

**In light of 'climate fatigue', consider reframing climate change from an environmental issue into another such as public health, social and economic sustainability, economic opportunity, etc.**

For further reading about this theme, consider:

- Kagawa, Fumiyo, and David Selby. 2010. "Introduction." In *Education and Climate Change: Living and Learning in Interesting Times*, edited by Fumiyo Kagawa and David Selby, 1–11. London: Routledge.
- Alexandar, R., and G. Poyyamoli. 2012. "Activity-based Water Resources and Climate Change Education among School Students in Puducherry." In *Climate Change and the Sustainable Use of Water Resources*, edited by Walter Leal Filho, 557–578. Climate Change Management series. New York and Heidelberg: Springer.
- NAAEE (North American Association for Environmental Education). 2004. Guidelines for Excellence: Environmental Education Materials. Washington, DC: NAAEE
- Brownlee, Matthew T. J., Robert B. Powell, and Jeffery C. Hallo. 2013. "A Review of the Foundational Processes That Influence Beliefs in Climate Change: Opportunities for Environmental Education Research." *Environmental Education Research* 19 (1): 1–20
- Wolf, J., and S. Moser. 2011. "Individual Understandings, Perceptions, and Engagement with Climate Change: Insights from In-Depth Studies across the World." *Wiley Interdisciplinary Reviews: Climate Change* 2: 547–56
- Maibach, E., M. Nisbet, P. Baldwin, K. Akerlof, and G. Diao. 2010. "Reframing Climate Change as a Public Health Issue: An Exploratory Study of Public Reactions." *BMC Public Health* 10: 299–309

## REMEMBER THE AUDIENCE

**Climate education must consider students' developmental stages. Students in kindergarten through grade 6 should primarily be exposed to environmental appreciation, environmental sensitivity, and ecological concepts, while issues, values, investigation, and action skills should become the major emphasis in students' later years (Grades 6-12).**

For further reading about this theme, consider:

- Volk, Trudi L., 1993. "Integration and Curriculum Design," in "Essential Readings in Environmental Education," edited by Dr. Harold Hungerford, 2005. Pp. 141 – 160.

<sup>4</sup> Wibeck, Victoria. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. *Environmental Education Research*. 20.

**Fear-based messaging is not effective when it comes to encouraging behavior change.**

For further reading about this theme, consider:

- Lorenzoni, I., Nicholson-Cole, S.A., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, 17, 445-459.
- Bonnici, T. (2007, February 3). Climate of fear: Stark warning. *The Sun*, pp. 26
- Hulme, M. (2007). Newspaper scare headlines can be counter-productive. *Nature*, 445, 818.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, 59, 329-349
- Lowe, T., Brown, K., Dessai, S., de Franca Doria, M., Haynes, K., & Vincent, K. (2006). Does tomorrow ever come? Disaster narrative and public perceptions of climate change *Public Understanding of Science*, 15, 435-457
- Futerra. (2005). *The rules of the game: The principles of climate change communication*. London: Author
- Moser, S. C., & Dilling, L. (2004). Making climate hot. *Environment*, 34, 32-46.
- Ereaut, G., & Segnit, N. (2006). *Warm words: How are we telling the climate story and can we tell it better?* London: Institute for Public Policy Research.
- Wibeck, Victoria. (2014). Enhancing learning, communication and public engagement about climate change – some lessons from recent literature. *Environmental Education Research*. 20.

**There is a shift from focusing on public understanding to public engagement. This is in response to the understanding that increased knowledge does not always translate to behaviour change. Possible communication approaches might include images, metaphors and computer technology to create simple visualizations that focus on solutions (as opposed to just problems).**

For further reading about this theme, consider:

- Anderson, Alison. 2012. "Climate Change Education for Mitigation and Adaptation." *Journal of Education for Sustainable Development* 6 (2): 191–206. Government of Alberta. 2017.
- Community Environmental Action Grant. UNESCO (United Nations Educational, Scientific, and Cultural Organization). 2009.
- Report of the UNESCO International Seminar on Climate Change Education, 27–29 July, Paris: UNESCO.
- Mutlu, Mehmet, and Halil Tokcan. 2013. "Success Effect of Documentary Use in Teaching of Global Warming Subject." *International Journal of Academic Research* 5 (5): 263–268
- Klosterman, Michelle L., and Troy D. Sadler. 2010. "Multi-level Assessment of Scientific Content Knowledge Gains Associated with Socioscientific Issues-based Instruction." *International Journal of Science Education* 32 (8): 1017–1043.
- Holthuis, Nicole, Rachel Lotan, Jennifer Saltzman, Mike Mastrandrea, and Andrew Wild. 2014. "Supporting and Understanding Students' Epistemological Discourse about Climate Change." *Journal of Geoscience Education* 62 (3): 374–387
- Linn, Marcia C., and Sherry Hsi. 2000. *Computers, Teachers, Peers: Science Learning Partners*. Mahwah, NJ: Erlbaum.
- Whitmarsh, L., G. Seyfang, and S. O'Neill. 2011. "Public Engagement with Carbon and Climate Change: To what Extent is the Public 'Carbon Capable'?" *Global Environmental Change* 21: 56–65.

## ACTION ORIENTED

**Emotional responses for regulating worry about global issues often leads to ‘distancing’ strategies - so focusing on taking action increases student agency, promotes feelings of hopefulness, and reduces negative emotions.**

**Dispelling misconceptions that are heavily supported by socio-cultural factors requires processes that allow learners to critically think about, defend and extend their ideas: explore where their ideas came from, unpack their own assumptions and perspectives in the context of sound science, and consider others’ perspectives.**

For further reading about this theme, consider:

- Monroe, Martha & R. Plate, Richard & Oxarart, Annie & Bowers, Alison & A. Chaves, Willandia. (2017). Identifying effective climate change education strategies: a systematic review of the research. Environmental Education Research. 1-22.
- Ojala, M. (2012b). Regulating worry, promoting hope: How do children, adolescents, and young adults cope with climate change? International Journal of Environmental & Science Education, 7 (4), 537–561.

**Educators should propose actions their audience could take in response to climate change (mitigation strategies for example), and make this personally relevant and meaningful.**

For further reading about this theme, consider:

- Hermans, Mikaela & Korhonen, Johan. (2017). Ninth graders and climate change: Attitudes towards consequences, views on mitigation, and predictors of willingness to act. International Research in Geographical and Environmental Education. 1-17.
- Li, Christine & Monroe, Martha. (2017). Exploring the essential psychological factors in fostering hope concerning climate change. Environmental Education Research. 1-19.
- Monroe, Martha & R. Plate, Richard & Oxarart, Annie & Bowers, Alison & A. Chaves, Willandia. (2017). Identifying effective climate change education strategies: a systematic review of the research. Environmental Education Research. 1-22.

## APPENDIX A: AN ANNOTATED LIST OF USEFUL NON-ACADEMIC PUBLICATIONS

### GOVERNMENT PUBLICATIONS

Government of Canada – Natural Resources Canada: Some resources and publications for the general public related to impacts and adaptions to climate change

<http://www.nrcan.gc.ca/environment/resources/publications/10766>

### GENERAL INFORMATION

**Climate Outreach:** A European organization whose mission includes ensuring climate change is effectively communicated. This site allows users to download from a series of guides and reports that could help to improve how climate change is communicated. <http://climateoutreach.org/>

**Involve.org:** A UK based group that has compared different techniques to promoting behaviour change (think, nudge, and push) and argue that they are complimentary to one another. <http://www.involve.org.uk/wp-content/uploads/2011/03/Nudge-think-or-shove.pdf>

**Canadian Association of Physicians for the Environment:** A group of Canadian physicians that have linked climate change to public health. Making this kind of connection could open up new avenues of research and collaboration for educators <https://cape.ca/what-we-do/climate-change/>

**The National Academies of Sciences, Engineering and Medicine:** A resource that contains specific information regarding the effective communication of climate change issues and specific research-based advice for educators - Informing an Effective Response to Climate Change (2010), <https://www.nap.edu/catalog/12784/informing-an-effective-response-to-climate-change>

**Dr. Lawrence Rose:** A pediatrician who has adapted Stoknes five-step paradigm to focus on considerations for children <http://www.iinusenvironmentalhealth.org/mobile/green-you-life/talking-with-children-about-climate-change/>

**PhD Gail Nelson:** Advises educators to use active hands-on approaches to help teach kids about climate change while reducing the risk of fear and helplessness for children. <https://www.psychologytoday.com/blog/why-the-wild-things-are/201505/what-do-children-know-about-climate-change>

**Beyond Doom and Gloom: Climate Solutions:** The Higher Education Associations Sustainability Consortium (HEASC) and the Disciplinary Associations Network for Sustainability (DANS), both in the U.S., created this initiative to empower students, educators and the public to advocate for climate solutions. <http://www.aashe.org/climate-solutions/>

**Climate Literacy: The Essential Principles of Climate Science:** The document from the United States Global Change Research Program provides a framework and essential principles for formal and informal education about climate change. The guide can serve educators who teach climate science as part of their science curricula.  
<http://www.globalchange.gov/browse/educators>

### MEDIA ARTICLES

**Inside Climate News:** A recent study in the U.S. shows that although climate change is often taught in middle and high school science classrooms, it is not often being taught correctly. The study's authors concluded that teachers could use more resources relating to climate science and provide assistance to teachers to help navigate the perceived controversies around climate change. <https://insideclimatenews.org/news/11022016/science-teachers-are-teaching-climate-change-not-always-correctly-education-global-warming>

### K-12 TEACHING RESOURCES

This section has been divided into two categories for ease of use: classroom-ready resources and tips.

Classroom-ready resources (and links):

**Alberta Council of Environmental Education** - resources for K-12 related to climate change and energy education  
<http://www.abcee.org/climate-change-energy-resources>

**Alberta Environment and Parks** – has created a climate change education resource for grades 4-6 which explains the difference between climate and weather, the basics of the greenhouse effect, some potential effects on Alberta and promotes energy efficiency as a means of tackling the issue. <http://aep.alberta.ca/about-us/documents/FocusOn-ClimateChange-2014.pdf>

**Canadian Red Cross** - Resources for educators and students that provide some introduction to climate change and correlate it with an increase in natural disasters. <http://www.redcross.ca/how-we-help/emergencies-and-disasters-in-canada/for-teachers-and-educators-of-children/help-students-learn-about-and-prepare-for-disasters/expect-the-unexpected-program>

**Canadian Wildlife Foundation** – created a series of education units for teachers with curriculum links explicitly pointed out. One such unit that is centred on climate change can be found at: <http://cwf-fcf.org/en/resources/for-educators/educational-units/climate-is-changing/>

**Climate Change Education** – a lengthy list of other resources for k-12 educators related to climate change. This link brings users to resources specific to Canada  
<http://climatechangeeducation.org/international/na/canada/k12/index.html>

**Climate Change Live** - a series of resources for climate change teachers and students  
<https://climatechangelive.org/index.php?pid=179>

**E.P.A.** – the United States Environmental Protection Agency has lesson plans focused on climate change and other topics. <https://www.epa.gov/students/lesson-plans-teacher-guides-and-online-resources-educators>

**Government of Manitoba** – a resource from Manitoba teachers to teach climate change education in the for grades 5-12 (the main resource also contains links to others) <http://www.edu.mb.ca/k12/esd/resources.html>

**Inside Education** – a series of resources for educators regarding climate change (and sustainability education).  
<http://www.insideeducation.ca/wp-content/uploads/2014/11/EnergyInnovationClimateChangePDResources.pdf?5fa2bf>

**GreenLearning Canada Foundation** – curriculum aligned education programs “Climate change where I live” and Cool 2.0 and online hub exploring climate change and sustainability.  
<http://www.greenlearning.ca/category/climate-education/>

**Green Teacher** – two books are available from that summarize the articles published in the Green Teacher Magazine about climate change. Teaching Teens about Climate Change and Teaching about Climate Change are both available at: <https://greenteacher.com/books/>

**Let's Talk Energy** – lesson plans and info graphics focused on climate change. Lesson plans focus on Society and Economy and Living World. <http://energy.techno-science.ca/en/resources/climate-change-lesson-plans.php>

**Live Learn and Plan** - a guide for teachers to teach climate change in the classroom with some considerations for approaches  
[http://www.livelearn.org/sites/default/files/docs/Climate%20change%20Teaching%20Manual\\_Eng\\_final\\_05032013.pdf](http://www.livelearn.org/sites/default/files/docs/Climate%20change%20Teaching%20Manual_Eng_final_05032013.pdf)

**National Education Association** – a series of suggestions for educators of climate change including baseline learning requirements and a few considerations for teachers. A number of teacher resources are included at the bottom of the webpage. <http://www.nea.org/home/65564.htm>

**National Geographic** - series of teacher resources for teachers to integrate climate change education into their classrooms <https://www.nationalgeographic.org/education/act-on-climate/>

**National Ocean Service** - Planet Stewards Education Project – webinars, book club and teacher professional learning <https://oceanservice.noaa.gov/education/planet-stewards/>

**N.A.S.A.** –has information, experiments, solutions and mitigation. <https://climatekids.nasa.gov/>

**P.E.E.L.** – this project was developed by Calgary teachers and stands for People for Energy and Environmental Literacy. They offer resources and training to teachers. <https://www.teachpeel.ca/>

**Unicef** – a list of resources for teachers related to climate change education  
[http://www.unicef.ca/sites/default/files/imce\\_uploads/UTILITY%20NAV/TEACHERS/DOCS/GC/cc\\_Teacher\\_Resources.pdf](http://www.unicef.ca/sites/default/files/imce_uploads/UTILITY%20NAV/TEACHERS/DOCS/GC/cc_Teacher_Resources.pdf)

**Climate Literacy and Energy Awareness Network (CLEAN)** - a series of lesson plans for educators to teach energy and climate change in the classroom (with pedagogy considerations, adaptations for grade levels, and advice for addressing persistent misconceptions) <https://cleanet.org/clean/literacy/index.html>

Tips:

**Climate Change Nova Scotia** - a teacher's guide has been created for Nova Scotia teachers to integrate climate change education which explains why it is important, the basics of it, common misconceptions, and a series of resources for teachers. [https://climatechange.novascotia.ca/sites/default/files/uploads/2012-2013\\_Dal\\_4.pdf](https://climatechange.novascotia.ca/sites/default/files/uploads/2012-2013_Dal_4.pdf)

**Danny Wagner** - advice for teachers to keep in mind when teaching climate change in the classroom  
<https://www.commonsense.org/education/blog/how-to-address-the-climate-change-debate-in-your-classroom>

**Jeffrey Bennet** - tips for teachers in the k-12 setting when trying to integrate climate change education into the classroom. <http://www.jeffreybennett.com/climate-change-education-hints-tips-teaching-kids-tell-whats-real/>

**Teach the Earth** – a guide for teachers to create lessons related to climate change by providing some simple steps to follow and resources to consider. <https://serc.carleton.edu/NAGTWorkshops/climatechange/index.html>

**United Nations** - this is a comprehensive guide for teachers on how to teach climate change in the k-12 classroom  
[https://www.unclearn.org/sites/default/files/inventory/resource\\_guide\\_on\\_integrating\\_cc\\_in\\_education\\_primary\\_and\\_secondary\\_level.pdf](https://www.unclearn.org/sites/default/files/inventory/resource_guide_on_integrating_cc_in_education_primary_and_secondary_level.pdf)

**UNESCO**: A series of activities for teachers to teach climate change in the classroom (also includes a bibliography and links to other related resources) - [http://www.unesco.org/education/tlfs/mods/theme\\_c/mod19.html](http://www.unesco.org/education/tlfs/mods/theme_c/mod19.html). Their 'Integrating Climate Change in Education at Primary and Secondary Level' is available at [https://www.unclearn.org/sites/default/files/inventory/resource\\_guide\\_on\\_integrating\\_cc\\_in\\_education\\_primary\\_and\\_secondary\\_level.pdf](https://www.unclearn.org/sites/default/files/inventory/resource_guide_on_integrating_cc_in_education_primary_and_secondary_level.pdf); The following captures their work to define climate change education:  
<http://unesdoc.unesco.org/images/0021/002197/219752e.pdf>

## APPENDIX B: AN ANNOTATED LIST OF PERTINENT PEER-REVIEWED RESEARCH

In order to provide a current synthesis on climate change education research, we focused our literature review efforts on recently published articles. We review and summarize over 140 articles in this Appendix and document. Research with similar findings are grouped together, but we've listed these alphabetically by authors, based on the first author listed.

**Ajzen, I. 1985. "From Intentions to Actions: A Theory of Planned Behavior."** In *Action-control: From Cognition to Behavior*, edited by J. Kuhl and J. Beckman, 11–39. Heidelberg: Springer.

**Bandura, A. 1997. Self-efficacy: The Exercise of Control.** New York: Freeman

**Hines, J. M., H. R. Hungerford, and A. N. Tomera. (1986) 1987. "Analysis and Synthesis of Research on Responsible Environmental Behavior: A Meta-analysis."** *Journal of Environmental Education* 18 (2): 1–8.

- Knowledge will not be sufficient in the promotion of a positive attitude, efficacy or engagement in environment.

**Akerlof, K., R. Debono, P. Berry, A. Leiserowitz, C. Roser-Renouf, K. Clarke, A. Rogaeva, M. Nisbet, M. Weathers, and E. Maibach. 2010. "Public Perceptions of Climate Change as a Human Health Risk: Surveys of the United States, Canada and Malta."** *International Journal of Environmental Research and Public Health* 7: 2559–2606.

- When reviewing samples of papers there are examples of some cross-country comparisons but still lacks acknowledgement of the fact that the public is not homogenous and there exist many different groups within the public.
- Proposes that segmenting the public into target groups would make CCC more effective and allow it to be elaborated upon and resonate within different groups (making more sense to the public as a whole).

**Alexandar, R., and Poyyamoll, G. 2012. "Activity-based Water Resources and Climate Change Education among School Students in Puducherry."** In *Climate Change and the Sustainable Use of Water Resources*, edited by Walter Leal Filho, 557–578. *Climate Change Management* series. New York: Springer

- Built on students' awareness of the importance of clean water and used this to generate a reason to understand the current climate impacts on water purity by imbedding climate change information in a unit on water quality for middle school students in coastal India.

**Anderson, Alison. 2012. "Climate Change Education for Mitigation and Adaptation."** *Journal of Education for Sustainable Development* 6 (2): 191–206.

**Government of Alberta. 2017. Community Environmental Action Grant.**

**UNESCO (United Nations Educational, Scientific, and Cultural Organization). 2009. Report of the UNESCO International Seminar on Climate Change Education, 27–29 July, Paris:** UNESCO.

- Attributes the growing interest in education about climate change to expanded funding and leadership for educational programs slated to address climate change.

**Balmford, A., A. Manica, L. Airey, L. Birkin, A. Oliver, and J. Schleicher. 2004. "Hollywood, Climate Change, and the Public."** *Science* 305: 1713

- Analysis based on pop culture representations such as "The Day After Tomorrow" and how they play a part in public awareness in climate change. While such visualizations are effective in bringing attention to the topic, there is much evidence showing that there is a danger here that feelings such as hopelessness and apathy will be brought forward through repeated use.

**Bandura, A. 1995. Self-efficacy in Changing Societies.** NY: Cambridge University Press.

**Bandura, A. 1997. Self-efficacy: The Exercise of Control.** New York: Freeman.

- Self-efficacy theory, refers to “the belief in one’s capabilities to find and execute courses of action and the expectations about the consequences of an action which help nurture effort, resilience, serenity, and optimism in the face of adversity and to solve problems”.
- In this case the BE (Being effective) was defined as: the belief that society and laypeople have the ability and skills to undertake actions( guided by Bandura’s Self-efficacy Theory).

**Basu, A., and R. Kaplan. 2015. “The Reasonable Person Model: Introducing the Framework and the Chapters.” In Fostering Reasonableness: Supportive Environments for Bringing Out Our Best, edited by R. Kaplan and A. Basu, 1–19. Ann Arbor, MI: Michigan Publishing**

- Reasonable Person Model: a synthesis of several theories that help describe the supportive environments that enable people to thoughtfully and helpfully engage in solving problems.
- This describes situations which are more prone to the creation of anger, frustration, apathy and other not so helpful feelings or attributes and explains supportive environments as those that meet our need for information.
- This makes this model relevant to education based interventions - taking into account that hopelessness and reasonableness do not stand as identical outcomes so they shouldn't be related.

**Bonnici, T. (2007, February 3). Climate of fear: Stark warning. The Sun, pp. 26**

**Sedgwick, M. (2001). Floodland. London: Orion.**

- Fear appeals in climate change are prevalent in the public domain, with the language of alarmism appearing in many guises. The use of fear appeals (in climate change) are widely used in the public domain and alarmist language is seen in a variety of forms.
- Bonnici referred to this in the media of a "climate of fear". Even children's books have been produced with fear messaging.

**Bowers, Alison W., Martha C. Monroe, and Damian C. Adams. 2016. “Climate Change Communication Insights from Cooperative Extension Professionals in the US Southern States: Finding Common Ground.” Environmental Communication 10 (5): 656–670**

**Sommers, Eleanor K. 2014. Agriculture and Climate Change: Perceptions of Reticent Extension Agents in the Southeast USA.**

**Wojcik, Deborah J., Martha C. Monroe, Damian C. Adams, and Richard R. Plate. 2014. “Message in a Bottleneck? Attitudes and Perceptions of Climate Change in the Cooperative Extension Service in the Southeastern United States.” Journal of Human Sciences and Extension 2 (1): 51–70**

- Because of the response of parents and the fear of damage to their own credibility and effectiveness many avoid teaching climate change at all.

**Bowler, R. M., and R. Schwarzer. 1991. “Environmental Anxiety: Assessing Emotional Distress and Concerns After Toxin Exposure.” Anxiety Research 4 (2): 167–180**

- Concern about Climate Change (Concern) was measured by a 4-degree scale from 1 (not at all) to 4 (a great deal) which was adapted from one statement from Environmental Worry Scale.

**Boykoff, M., and J. Boykoff. 2004. “Bias as Balance: Global Warming and the US Prestige Press.” Global Environmental Change 142: 125–136**

**Schweitzer, S., J. Thompson, T. Teel, and B. Bruyere. 2009. “Strategies for Communication about Climate Change Impacts on Public Lands.” Science Communication 31: 266–274.**

- There is a false sense that climate change has as many skeptics that are as influential as scientists who support the notion that there are human induced causes of climate change. This has been contributed to largely by the journalistic practice of giving equal weight to both sides of a debate.

**Brönniman, S. 2002. “Picturing Climate Change.” Climate Research 22: 87–95 Manzo, K. 2010. “Beyond Polar Bears? Re-envisioning Climate Change” Meteorological Applications 17: 196–208.**

- Making climate change "visible" the use of linguistic means (metaphors or images) has been emphasized.

**Brossard, D., and B. Lewenstein.** 2009. "A Critical Appraisal of Models of Public Understanding of Science: Using Practice to Inform Theory." In *Communicating Science: New Agendas in Communication*, edited by L. Kahlor and P. Stout. New York, NY: Routledge.

**Lewenstein, B., and D. Brossard.** 2006. *Assessing Models of Public Understanding in Elsi Outreach Materials: Final Report*. Ithaca, NY: Cornell University

- Many studies of the public understanding of climate change rely on the so-called "information deficit model" and treat basic science education as a potential solution or remedy to the issues of public lack of interest and mistrust in climate change.
- Often public participation activities are seen as having an explicit goal of democratizing science by empowering public groups in order to engage them in the issue. This is seen by some as a political and not scientific agenda.

**Brossard, D., J. Shanahan, and K. McComas.** 2004. "Are Issue-Cycles Culturally Constructed? A Comparison of French and American Coverage of Global Climate Change" *Mass Communication and Society* 7: 359–377.

**Weingart, P., A. Engels, and P. Pansegrouw.** 2000. "Risks of Communication: Discourses on Climate Change in Science, Politics, and the Mass Media." *Public Understanding of Science* 9: 261–283.

- When analyzing news media framings of climate change there have been marked difference in how it is described in different national contexts. e.g. Sweden, France, Germany

**Brownlee, Matthew T. J., Robert B. Powell, and Jeffery C. Hallo.** 2013. "A Review of the Foundational Processes That Influence Beliefs in Climate Change: Opportunities for Environmental Education Research." *Environmental Education Research* 19 (1): 1–20

**Harris, Paul G.** 2009. *World Ethics and Climate Change: From International to Global Justice*. Edinburgh: Edinburgh University Press.

- Another approach is through interventions acknowledging the psychosocial, evolutionary and ethical aspects of climate change.

**Boyes, E., Stanisstreet, M., Skamp, K., Rodriguez, M., Malandrakis, G., Fortner, R., ... Hye-Gyoung, Y.** (2014). An international study of the propensity of students to limit their use of private transport in light of their understanding of the causes of global warming. *International Research in Geographical and Environmental Education*, 23(2), 142–165.

**Ambusaidi, A., Boyes, E., Stanisstreet, M., & Taylor, N.** (2012). Omani students' views about global warming: Beliefs about actions and willingness to act. *International Research in Geographical and Environmental Education*, 21(1), 21–39.

- Studies have shown the level of worry about climate change is quite high in secondary students.

**Campbell, P.** 2011. "Understanding the Receivers and the Reception of Science's Uncertain Messages." *Philosophical Transactions of the Royal Society A* 369: 4891–4912

- Research from earlier years indicates that while on the public agenda, climate change in a communicative context (at least in North America and Europe) is firmly characterized by uncertainty, controversy and an ongoing debate.

**Carvalho, A., & Burgess, J.** (2005). Cultural circuits of climate change: An analysis of representations of "dangerous" climate change in the UK broadsheet press 1985–2003. *Risk Analysis*, 25, 1457-1469.

**Trumbo, C. W., & Shanahan, J.** (2000). Social research on climate change: Where we have been, where we are, and where we might go. *Public Understanding of Science*, 9, 199–204.

- The mass media is the most significant channel of information that the public receives- particularly about climate change and therefore also arguably has a great influence on people's perceptions.

**Chawla, L., & Flanders Cushing, D.** (2007). Education for strategic environmental behavior. *Environmental Education Research*, 13(4), 437–452.

- There hasn't been a direct study of the link between interest in environmental issues and the willingness to act but it is often asserted that an interest would positively relate to pro-environmental behaviour.
- Effect of private actions is limited unless it is combined with organizing for collective public change.
- Pre-school and elementary – focus on small-scale action at the classroom, school yard or local level.

**Chen, Xiang. 2011. "Why Do People Misunderstand Climate Change? Heuristics, Mental Models and Ontological Assumptions." Climatic Change 108 (1–2): 31–46**

**Sterman, John D. 2011. "Communicating Climate Change Risks in a Skeptical World." Climatic Change 108 (4): 811**

- There are several aspects of climate change that can make it difficult to teach, among those is the fact that while educators attempt to put forward accurate information through school programs there are simply too many extension courses and non-formal venues which convey misconceptions and splintered information for the school programs messaging to be as effective as it needs to be.

**Chopyak, J., and P. Levesque. 2002. "Public Participation in Science and Technology Decision Making: Trends for the Future." Technology in Society 24: 155–166**

**Delgado, A., K. Kjolberg, and F. Wickson. 2011. "Public Engagement Coming of Age: From Theory to Practice in STs Encounters with Nanotechnology." Public Understanding of Science 20: 826–845**

**Rogers-Hayden, T., and N. Pidgeon. 2007. "Moving Engagement "Upstream"? Nanotechnologies and the Royal Society and Royal Academy of Engineering's Inquiry" Public Understanding of Science 16: 345–364.**

- The trend towards a discussion of public engagement has been noted for other issues of science, technology and policy as well as climate change.... particularly including biotechnology and nanotechnology

**Cooney, C. 2010. "The Perception Factor. Climate Change Gets Personal." Environmental Health Perspectives 118: A485–A488.**

- Focus should be on CCC solutions rather than simply the problems themselves to further promote public engagement.

**Corner, A., and A. Randall. 2011. "Selling Climate Change? The Limitations of Social Marketing as a Strategy for Climate Change Public Engagement" Global Environmental Change 21: 1005–1014**

- When involving climate change as well as other problems perceived as being bigger than self, there has been hesitation in addressing issues not in immediate self-interest to solve/ contribute to solving.
- The importance of how climate change is framed is again highlighted in that this is how it makes most sense to lay audiences and influence public engagement
- There are arguments that "deep framing" - connections forged between particular communicating strategies/ public policies and deeper values or principals - offers a method of "linking climate change engagement strategies with values that are more conducive to solving bigger-than-self problems".
- Exercises which engage the public in deliberating on climate-related issues could also take advantage of peer-to-peer learning, which has been suggested as a fruitful way of overcoming problems related to more top-down models of communication, such as a lack of trust in the institutions communicating climate change.

**Dilling, Lisa, and Susanne C. Moser. 2007. "Introduction." In Creating a Climate for Change, edited by Susanne C. Moser and Lisa Dilling, 1–28. Cambridge, NY: Cambridge University Press**

**Kahan, Dan. 2009. "Ideology in" or "Cultural Cognition of" Judging: What Difference Does It Make? Faculty Scholarship Series. Paper 4689**

- Educators should also consider social factors (group identity, threats of values posed by solutions, lack of political will, media balance of opposing views) as these make it challenging to properly explore climate change and solutions.

**Dillon, J. 2003. "On Learners and Learning in Environmental Education: Missing Theories, Ignored Communities." Environmental Education Research 9: 125–226.**

- Many contemporary scholars of learning take on a constructivist view of learning and emphasize the importance of the context in which learning is situated.
- Make arguments that constructivist theories of learning are endorsed by many researchers in the field. These perspectives emphasize building knowledge through social interactions. Through that dialogue we become more knowledgeable.
- There is debate about whether the context in which learning is taking place matters. Is there really a need for any facilitator of learning to consider the communicative context for climate change education while also exploring the learners' pre-existing perceptions of climate change?

**Donner, S. 2011. "Making the Climate a Part of the Human World." Bulletin of the American Meterological Society 92: 1297–1302.**

- Earlier research suggests that although climate change is now firmly put on the public agenda, the communicative context of climate change, at least in Europe and North America, is characterized by ongoing debate, uncertainty and controversies of various kinds.
- Point to the importance of political orientation, worldviews and religious views in influencing the level of public engagement.

**Doyle, J. 2007. "Picturing the Clima(C)tic: Greenpeace and the Representational Politics of Climate Change Communication." Science as Culture 16: 129–150.**

- Further discuss how these images produce a distancing effect- taking the impacts and making them seem to affect animals and their habitats and not as much humans.

**Ereaut, G., & Segnit, N. (2006). Warm words: How are we telling the climate story and can we tell it better? London: Institute for Public Policy Research.**

- Reiterated that continual and repeat exposure to fear messages and representations of climate change may cause the opposite of the intended reaction. This may damage the reputation of those using these messages, or further damage to the message itself. It gave the notion of causing the message to become laughable as opposed to being taken seriously.
- Named one the public discourses "settlerdom" and furthered to state this discourse rejects and mocks an alarmist discourse.

**Etkin, D., and E. Ho. 2007 "Climate Change: Perceptions and Discourses of Risk." Journal of Risk Research 10: 623–641**

**Sterman, J., and L.B. Sweeney. 2007. "Understanding Public Complacency about Climate Change." Climatic Change 80: 213–238.**

- Scientists have studied for over a decade to determine the level of public understanding of climate change. (e.g. does the typical layperson understand or misunderstand climate change science).
- Summarizes earlier research: specifically, laypeople's difficulties in complex thinking and thinking probabilistically.
- Makes claim that, based on a study by McComas and Shanahan (1999), that there is 'a lack of cultural narratives within which the debate can be placed'.

**Featherstone, H., E. Weitkamp, K. Ling, and F. Burnet. 2009. "Defining Issue-Based Publics for Public Engagement: Climate Change as a Case Study." Public Understanding of Science 18: 214–228.**

**Maibach, E., and S. Hornig Priest. 2009. "No More 'Business as Usual': Addressing Climate Change through Constructive Engagement." Science Communication 30: 299–304.**

- There are many different publics and the scientific community needs to keep this in mind when addressing messaging.
- More studies seem to indicate there is a need for public participation in climate science and policy matters.

**Feinberg, M., and R. Willer. 2011. "Apocalypse Soon?: Dire Messages Reduce Belief in Global Warming by Contradicting Just-World Beliefs" Psychological Science 22: 34–38.**

- Highlight the shortcomings of fear based communications for climate change. Regards such communications as having a negative impact, causing apathy and hopelessness even though they initially show promise in catching the attention of the public.

**Few, R., K. Brown, and E. Tompkins. 2007. "Public Participation and Climate Change Adaptation: Avoiding the Illusion of Inclusion." Climate Policy 7: 46–59**

- More research is needed as to how to achieve more meaningful and secure broad based public engagement.
- For participatory exercises to be more successful, the people need to be willing to not only their time but their ideas but since public participation events are often set up to only include a limited number of participants there is a risk that only particular groups (special interest or elite) opt to participate

**Funtowicz, S., and J. Ravetz. 1993. "Science for the Post-Normal Age." Futures 25: 739–755.**

**Nowotny, H., P. Scott, and M. Gibbons. 2001. Re-thinking Science: Knowledge and the Public in an Age of Uncertainty. Cambridge: Polity Press.**

- The authors argue there needs to be more involvement from a so-called "extended peer community".

**Futerra. (2005). The rules of the game: The principles of climate change communication.**

- Added to the idea that repeated use of fear approaches or the use of fear approaches without complete thought and consideration as to all the long-term outcomes would be ill conceived and pose damage (in some cases further damage) to the reputation of the organizations using them to communicate climate change impact. Considers this key when thinking about the need for sustained, consistent messaging in climate change communications.

**Gamson, W., and A. Modigliani. 1987. "The Changing Culture of Affirmative Action." In Research in political sociology, vol 3, edited by R. Braungart and M. Braungart. Greenwich, CT: JAI Press.**

**Koteyko, N., M. Thelwall, and B. Nerlich. 2010. "From Carbon Markets to Carbon Morality: Creative Compounds as Framing Devices in Online Discourses on Climate Change Mitigation." Science Communication 32: 25–54**

- When framing climate change, media could focus on what could be seen as the core of the issue (e.g. linkages between events are suggested, propose what should be seen as responsible and suggest how problems should be handled).

**Gold, Anne U., Karin Kirk, Deb Morrison, Susan Lynds, Susan Buhr Sullivan, Andrey Grachev, and Ola1 Persson. 2015. "Arctic Climate Connections Curriculum: A Model for Bringing Authentic Data into the Classroom." Journal of Geoscience Education 63 (3): 185–197**

- There are benefits to integrating scientists' and teachers' skills. When involved as collaborators on program development teachers showed confidence in then teaching and facilitating student studies in the nature of science.
- When these teachers then reported areas of struggle it was easier for developers to make changes and provide additional instructions, figures.

**Grønhaug, A., & Thøgersen, J. (2009). Like father, like son? Intergenerational transmission of values, attitudes, and behaviours in the environmental domain. Journal of Environmental Psychology, 29(4), 414–421.**

- Parental engagement is important in development of students' pro-environmental behaviours and is an important predictor of these behaviours among secondary students.

**Grob, A. 1995. "A Structural Model of Environmental Attitudes and Behaviour." Journal of Environmental Psychology 15: 209–220**

**Kollmuss, A., and J. Agyeman. 2002. "Mind the Gap: Why People Act Environmentally and What are the Barriers to Pro-Environmental Behaviour?" Environmental Education Research 8: 239–261.**

- These articles discuss the 'value-action gap' or the 'attitude-behavior divide'. This involves an exploration as to why there is not a direct causal relationship between knowledge increase and behaviour change.

**Guy, S., Kashima, K., Walker, I., and O'Neill, S. 2014. "Investigating the Effects of Knowledge and Ideology on Climate Change Beliefs." European Journal of Social Psychology 44 (5): 421–429**

- Proposes that the design and implementation of programs about climate change requires not only the balance of the increasing knowledge of the topic itself but also the acknowledgement of the part that cultural ideology plays in perception and learning.

**Haidt, Jonathan. 2012. The Righteous Mind: Why Good People are Divided by Politics and Religion. New York: First Vintage Books, Random House.**

**Kahan, Dan. 2010. "Fixing the Communications Failure." Nature 463: 296–297.**

**Kinder, Donald R. 1998. "Opinion and Action in the Realm of Politics." In Handbook of Social Psychology, edited by Daniel Gilbert, Susan Fiske, and Gardner Lindzey, 778–867. New York: McGraw-Hill.**

- Asks that there be recognition (and that there is some) that the approach to climate change is different than the way other environmental issues are approached. While there is a certain complexity and uncertainty surrounding the topic, more so than the plentiful ethical controversies (hazardous waste placement, plummeting biodiversity) that require careful thought and attention, the topic itself resonates within held values and a way of life (adults often respond by protecting their group identity and way of life).
- Shows that one outcome of this is the tendency to seek/ recall information that reinforces the individuals initial judgement (confirmation bias).

**Hamblin, R. 2009. "The Whistleblower and the Canary: Rhetorical Constructions of Climate Change." Journal of Historical Geography 35: 223–236.**

- Draws comparisons to the canaries in the coal pits until the late 1980s in Britain to those instances of wake up calls on an individual scale that have served to alert people to the broader perils. (canaries in the case would be glaciers or ice caps in retreat or dramatic fragmentation) Caution is given however that the images of the floods, the polar bears, melting ice caps are all used commonly in climate change communication and serve to frame it all as a faraway issue rather than alert the public of the need to see changes in everyday behaviours.

**Hastings, G., Stead, M., & Webb, J. (2004). Fear appeals in social marketing: Strategic and ethical reasons for concern. Psychology & Marketing, 21, 961-986.**

- Draws a question as to the value of models used which were based on experiments which used psychology or marketing students as subjects in relation to real world communications environments.
- Goes further into the consequences of long term reliance on fear appeals and how it is possible that a law of diminishing returns may exist. (If so, fear approaches then need to be made more intense over time as individuals become desensitized to the threatening information from long term exposure).
- Brings up the point that people are faced all the time with a barrage of multimedia messages and do not blindly trust every bit of information they receive. They are becoming increasingly aware of the power of the media and are using more critical approaches to how they perceive information being given to them.
- States a limitation of lab studies in that, in a lab setting a particular fear approach is stated as being very motivating but in practical ones it is not. Arguably this is because individuals often to some degree understand the result the study is intended to achieve and while not personally afraid of the approaches presented give answers based on what they think the study is trying to achieve.

**Heberlein, T.A. (2012). Navigating environmental attitudes. Oxford: Oxford University Press.**

- Attitudes that influence pro environmental behavior have been demonstrated. There is a demonstrated link between worry and the willingness to act.

**Hicks, David, Bord, Andy. (2001). "Learning about global issues: why most educators only make things worse"**

- Need to deal with global issues in three areas: cognitive, affective and existential (mind, heart and soul).

**Holthuis, Nicole, Rachel Lotan, Jennifer Saltzman, Mike Mastrandrea, and Andrew Wild. 2014. "Supporting and Understanding Students' Epistemological Discourse about Climate Change." Journal of Geoscience Education 62 (3): 374–387**

- Explored the use of conversation and its fundamental nature.
- It was suggested that student interactions instead of simply listening intently is a very important factor in learning gains here. Specifically, there was an importance of "epistemic" discussion (how do we know) allowing students to practice making a claim, support it with evidence.

**Howell, R. 2011. "Lights, Camera ... Action? Altered Attitudes and Behaviour in Response to the Climate Change Film the Age of Stupid" Global Environmental Change 21: 177–187.**

- Discusses the idea that unless people believe they can "do something" about the problem AND that it is worth doing, it is very difficult to promote engagement.
- Shares how positive stories about people (not environmentalists but "ordinary" people) take action on climate change is viewed as a promising approach for CCC. Especially as such stories use the power of constructive social norms that have been argued as having a positive feedback on individual action and public engagement.

**Hudson, Stewart J. 2001. "Challenges for Environmental Education: Issues and Ideas for the 21st Century."**

**BioScience 51(4): 283–288.**

- One approach being taken is building critical thinking skills, helping youth understand not only the conflicts surrounding climate change and their sources but to help them build problem solving skills (help youth conduct local projects focused on mitigation and adapting to climate changes).

**Hulme, M. (2007). Newspaper scare headlines can be counter-productive. Nature, 445, 818.**

- Conducted a study into the coverage of the IPCC Working Group I report in 10 UK national newspapers. One of them did not run any stories on the IPCC report and the other nine ran articles using words like "shocking", "catastrophic", "terrifying"... none of these words are present in the actual IPCC document.
- Concludes fear's prevalence in climate change communications does not stem from the actual science of climate change.
- Mass media has a tendency towards alarmist tones and messaging and it does have a counterintuitive effect on the public's engagement with climate change.

**Hulme, M. 2009. Why We Disagree About Climate Change: Understanding Controversy, Inaction and Opportunity. Cambridge: Cambridge University Press.**

- When discussing sociocultural preconditions regarding laypersons' understanding of climate change it is referring to social norms, and ideologies as well as values and their importance in influencing public engagement with climate change.

**IPCC. (2014a). Climate change 2014: Mitigation of climate change. Contribution of working group III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.**

**IPCC. (2014b). Climate change 2014: Impacts, adaptation, and vulnerability. Working group II contribution to the fifth assessment report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University.**

- IPCC has determined a need for an effective and immediate response to issues like climate change
- Climate change has been shown to pose serious risks to both human and natural systems and so ultimately intervention needs to be at the human level to prevent further hazardous consequences with the climate system.

**Jensen, B.B. (2002). Knowledge, action and pro-environmental behaviour. Environmental Education Research, 8(3), 325–334.**

- Further demonstrates that "understanding" of environmental problems is mostly limited to scientifically oriented perspective dealing with consequences and not the issues as a whole. An approach that focuses on root causes, strategies for change AND the consequence would develop students' attitudes as well as the behaviours positively and therefore encourage a willingness to act.

**Kagawa, Fumiyo, and David Selby. 2010. "Introduction." In Education and Climate Change: Living and Learning in Interesting Times, edited by Fumiyo Kagawa and David Selby, 1–11. London: Routledge.**

- State their goal for climate change as 'the learning moment can be seized to think about what really and profoundly matters, to collectively envision a better future, and then to become practical visionaries in realizing that future.'

**Kahlor, L., and S. Rosenthal. 2009. "If We seek, Do We Learn? Predicting Knowledge on Global Warming" Science Communication 30: 380–414.**

**Ryghaug, M., K. Sorensen, and R. Naess. 2011. "Making Sense of Global Warming: Norwegians Appropriating Knowledge of Anthropogenic Climate Change." Public Understanding of Science 20: 778–795.**

- The idea of the decisive role of the news media in shaping the public perception and understanding of scientific issues has been tackled by many studies. Television, newspaper and the internet often are seen as bridges between the scientific community and the public
- More public participation in climate change and policy matters is being called for by many studies.

**Kaplan, S., and R. Kaplan. 2009. "Creating a Larger Role for Environmental Psychology: The Reasonable Person Model as an Integrative Framework." Journal of Environmental Psychology 29 (3): 329–339**

- Model building, meaningful action, and being effective seem to be very significant correlation to hope.

**Kaplan, S., and R. Kaplan. 1982. Cognition and Environment: Functioning in an Uncertain World. New York: Praeger.**

- Personal Relevance: the challenge and goal are similar to many in other educational contexts. This is a prerequisite for "good education", learners will link what they already know with the new materials and ideas. This creates interest and attention to the information.

**Kevorkian, K. 2004. "Environmental Grief: Hope and Healing." PhD diss., Union Institute and University, Cincinnati, OH**

- Solutions to the issue of climate change will require dedicated engagement by many people. Their involvement will be more likely if they feel hopeful about the challenge and not bogged down by fear messaging.
- Many environmental psychologists and mental-health professionals refer to this as "environmental grief" and "eco despair" and agree it is a barrier to engagement.

**Klosterman, Michelle L., and Troy D. Sadler. 2010. "Multi-level Assessment of Scientific Content Knowledge Gains Associated with Socioscientific Issues-based Instruction." International Journal of Science Education 32 (8): 1017–1043.**

- Conversations among learners are effective in helping them to think more deeply about concepts and to compare their own perceptions to others', understand different opinions and then to reflect on what they know and what they observe.

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

- Concludes link between pro-environmental behaviours and the understanding of the issues involved is weak.
- However, worry when combined with a feeling that the situation cannot be changed through individual actions alone and can result in apathy.

**Lazo, J., J. Kinnell, and A. Fischer. 2000. "Expert and Layperson Perceptions of Ecosystem Risk." Risk Analysis 20: 179–194.**

- Talks about the claim that lay people's mental models are less specific than that of an expert and are less suited to understanding the complexities of climate change.

**Leiserowitz, Anthony, Nicholas Smith, Jennifer R. Marlon. 2011. American Teens' Knowledge of Climate Change. New Haven, CT: Yale Project on Climate Change Communication**

**Shepardson, Daniel P., Dev Niyogi, Soyoung Choi, and Umarporn Charusombat. 2009. "Seventh Grade Students' Conceptions of Global Warming and Climate Change." Environmental Education Research 15 (5): 549–570**

**Taber, Fiona, and Neil Taylor. 2009. "Climate of Concern—A Search for Effective Strategies for Teaching Children about Global Warming." International Journal of Environmental and Science Education 4 (2): 97–116.**

- Contend that most young people do not harbour even a basic understanding of climate science and that this makes it difficult to properly delve into areas of climate change communication.

**Leiserowitz, A., E. Maibach, C. Roser-Renouf, and N. Smith. 2011a. "Climate Change in the American Mind: Americans' global Warming Beliefs and Attitudes in May 2011." Yale University and George Mason University. New Haven, CT: Yale Project on Climate Change Communication.**

- At least in the USA and UK context, there has been a decline in public concern about climate change over the last few years.
- Traditionally "audience segmentation" is dividing subpopulations by traits such as gender, age or socioeconomic background" and this is not satisfactory when organizing climate change communication activities. Demographics alone, it is argued, cannot predict attitudes or practices and an alternative strategy would see the division based on psychosocial variables such as climate change risk perceptions, media use and policy preferences.

**Linn, Marcia C., and Sherry Hsi. 2000. Computers, Teachers, Peers: Science Learning Partners. Mahwah, NJ: Erlbaum.**

- Educators should make content more accessible connecting it to personally relevant ideas or experiences, even by building on student ideas.
- They should help students to learn from one another and compare ideas as well as debate their perspectives and viewpoints.
- Use of models, visuals and data collection/ analysis makes thinking "visible".
- All of this together can help to promote lifelong learning. Furthered by creation of an inquiry process and giving motivation towards its use.

**Linville, P. W., & Fischer, G. W. (1991). Preferences for separating and combining events: A social application of prospect theory and the mental accounting model. Journal of Personality and Social Psychology, 60, 5-23.**

- The "finite pool of worry" theory states that increased concern for one risk may outweigh or decrease the concern over other risks. Poses the idea that individuals only have a certain capacity for worry.

**Lorenzoni, I., M. Jones, and J. Turnpenny. 2007. "Climate Change, Human Genetics, and Post-Normality in the UK." Futures 39: 65–82**

- The need for public participation has been driven largely by insight that climate change management is being based on "value-driven decisions made in the face of risk and uncertainty"
- Makes the argument that decisions should involve decentralized public-sphere politics and multilayered democratic participation as this could enable a more diverse perspective and broader knowledge base to

contribute while fostering things like mutual learning/ reflexivity and an evaluation of trade-offs/ uncertainties and their distribution.

**Lorenzo, I., Nicholson-Cole, S. A., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, 17, 445-459.**

- Defines "engagement" as: a state of connection comprising the three codependent spheres of cognition, affect, and behavior. On one hand, individuals can be engaged as citizens responsible both for influencing policy through elections in a democratic society and for driving consumption patterns and trends through their purchasing power.
- Found many considered scenarios such as the UK's targets for 2050 (and the fear messaging around it) to be so far into the future that they were almost not relevant, or hypothetical in nature.
- Discussed two mechanisms. The external fear and the internal fear. The idea that if the external danger (e.g. impacts of climate change) cannot be controlled (or not perceived as being controllable) then individuals will attempt to control the second mechanism of internal fear. These controls include issue denial, apathy and can represent barriers to meaningful engagement.
- While use of catastrophic and large-scale representations initially serve to catch people's attention regarding issue of climate change they do not motivate a sense of personal engagement and therefore can actually act to trigger barriers to engagement. (denial and others above)
- While a lack of knowledge is among the barriers present to public engagement - it is often in how it interacts with others such as social norms, worldviews and lack of agency that makes it a larger issue.
- This demonstrates the importance of communications approaches that take account of individual points of reference (e.g. based on understanding and appreciation of values, attitudes, beliefs, local environment and experiences) in inspiring personal engagement with the issue of climate change

**Loughard, T., Reid, A., Walker, K., Petocz, P. (2003) "Factors Influencing Young People's Conceptions of Environment", *Environmental Education Research Journal*, 9(1):3-19**

- Study of Australian students indicates environmental concern peaks between ages 11 – 12; girls have more of a relation concept with environment; boys have more of an object concept of environment. Subject specific curriculum not effective in creating opportunities to integrate ecological values.

**Lowe, T., Brown, K., Dessai, S., de Franca Doria, M., Haynes, K., & Vincent, K. (2006). Does tomorrow ever come? Disaster narrative and public perceptions of climate change *Public Understanding of Science*, 15, 435-457.**

- Believe fear inducing reports are unlikely to have long term impacts.
- A pre/post-test survey conducted after watching the movie "The Day After Tomorrow" was conducted and themes were followed up a month later with focus groups. Although 67% of participants in the post-test agreed that "everybody has to do something" about the issue of climate change the sense of urgency diminished extensively in the focus groups held a month later.
- Concluded that the research indicates individuals are likely to feel removed from climate change - as though it will not affect them for many years, if at all in their lifetimes.
- Brings up the fact that the public are not homogenous and need different approaches in order to be reached effectively as a whole.

**Maibach, E., C. Roser-Renouf, and A. Leiserowitz. 2008. "Communication and Marketing as Climate Change-Intervention Assets. A Public Health Perspective." *American Journal of Preventive Medicine* 35: 488–500.**

- Argues there are four areas in which mitigation action could take place on an individual scale: reduction in household energy use, recycling, green consumerism and surface transportation behaviours.

**Maibach, E., M. Nisbet, P. Baldwin, K. Akerlof, and G. Diao. 2010. "Reframing Climate Change as a Public Health Issue: An Exploratory Study of Public Reactions." *BMC Public Health* 10: 299–309**

- There are signs within certain sectors of the American public of issue fatigue, which highlights the importance of how climate change is framed for it to make the most sense to lay audiences and therefore influence public engagement.

- Focusing CCC on solutions rather than on problems is also suggested as a strategy for enhancing public engagement.

**McCright, A. 2011. "Political Orientation Moderates Americans' Beliefs and Concern about Climate Change."**  
**Climatic Change 204: 243–253**

- Point to the importance of political orientation, worldviews and religious views in influencing the level of public engagement.

**McNeal, Karen S., Julie C. Libarkin, Tamara Shapiro Ledley, Erin Bardar, Nick Haddad, Kathy Ellins, and Saranee Dutta. 2014. "The Role of Research in Online Curriculum Development: The Case of EarthLabs Climate Change and Earth System Modules."** *Journal of Geoscience Education* 62 (4): 560–577

- Saw that the increase in systems understanding was due mostly to instructional focus on students' exploration of changes taking place on many different scales including those considered outside of human perception (e.g. over millennia).

**Monroe, M. C., and A. Oxarart, eds. 2014. Southeastern Forests and Climate Change: A Project Learning Tree Secondary Environmental Education Module.** Gainesville: University of Florida and American Forest Foundation.

- Follow up activities can be used to increase competence in students by discussing how different scenarios could affect forests/ management options to help the forest thrive.

**Monroe, Martha C., Annie Oxarart, and Richard R. Plate. 2013. "A Role for Environmental Education in Climate Change for Secondary Science Educators."** *Applied Environmental Education & Communication* 12 (1): 4–18.

**Plutzer, Eric, Mark McCaffrey, A. Lee Hannah, Joshua Rosenau, Minda Berbeco, and Ann H. Reid. 2016. "Climate Confusion among U.S. Teachers."** *Science* 351: 664–665

- Further to the fear of damaged reputations, many express not feeling they have adequate understanding and knowledge themselves to teach climate change effectively.

**Morris, Hilary L. C., Mark A. Megalos, Aaron J. Vuola, Damian C. Adams, and Martha C. Monroe. 2014. "Cooperative Extension and Climate Change: Successful Program Delivery."** *Journal of Extension* 52 (2)

**Tyson, Richard. 2014. "The Merits of Separating Global Warming from Extension Education Sustainability Programs."** *The Journal of Extension (JOE)*.

- Further to the hesitation in teaching the topic because of parents' response, teachers feel concern that addressing climate change could decrease their own effectiveness and damage their credibility.

**Moser, S. 2006. "Talk of the City: Engaging Urbanites on Climate Change."** *Environmental Research Letters* 1: 1–10.

- There are two crucial roles played by individuals in climate mitigations:
  1. They exert influence as consumers through consumption patterns of environmental resources, material goods and energy.
  2. They exert a political influence by choosing to support policies that are environmentally and climate friendly.

**Moser, S. C., & Dilling, L. (2004). Making climate hot. Environment, 34, 32-46.**

- Continued use of fear messages can lead to one of two psychological functions: controlling the external danger or controlling the internal fear and this should be kept in mind when approaching communications regarding climate change.

**Moser, S., and L. Dilling. 2004. "Making Climate Hot: Communicating the Urgency and Challenge of Global Climate Change."** *Environment* 46: 32–46.

- There is lots of practical evidence that many public education and communication strategies have been unsuccessful.

- 'The creeping nature of climate change, its complexity and uncertainty, system lags, human perception limits, and communication failures on the part of scientists'
- Relates it has been demonstrated that although "doomsday" messaging has been shown to increase public awareness, these same narratives have also been shown to induce feelings of hopelessness and even apathy
- Another large issue in making climate change relevant and tangible on a public scale is that is not easily seen and is often intangible in character.

**Mutlu, Mehmet, and Halil Tokcan. 2013. "Success Effect of Documentary Use in Teaching of Global Warming Subject." International Journal of Academic Research 5 (5): 263–268**

- Used visual imagery to spark interest and form a connection with audiences.
- In Turkey, pre-service teachers watched the movie "An Inconvenient Truth" during a unit on climate change. Afterward they demonstrated many learning gains comparatively to the control group who did not watch the film.

**NAAEE (North American Association for Environmental Education). 2004. Guidelines for Excellence: Environmental Education Materials. Washington, DC: NAAEE**

There are two themes which were identified as helping programs be more successful and are actually very common in environmental education programs on any topic:

1. They made climate change information more relevant on a personal level and therefore more meaningful for learners.
2. Activities and educational interventions were designed specifically to engage learners.

**Nisbet, M. 2009. "Communicating Climate Change: Why Frames Matter for Public Engagement." Environment 51: 12–23**

- Mass media and how things are framed within it greatly influences how people perceive and react to issues.
- Argue that the public sees climate change as being wholly ambiguous due to its complexity and the perceived uncertainty.

**Nisbet, M., and D. Scheufele. 2009. "What's Next for Science Communication? Promising Directions and Lingering Distractions" American Journal of Botany 96: 1767–1778.**

- Understanding of the science paradigm by the public still informs and shapes many science communications initiatives causing a departure from the idea that public knowledge deficits are the central force driving conflicts of a societal nature over science.

**Norton, T., P. Sias, and S. Brown. 2011. "Experiencing and Managing Uncertainty about Climate Change." Journal of Applied Communication Research 39: 290–309.**

- Makes the argument that messages will have a greater impact when they target issues that are relevant to local action takers.

**Ockwell, D., L. Whitmarsh, and S. O'Neill. 2009. "Reorienting Climate Change Communication for Effective Mitigation: Forcing People to be Green or Fostering Grass-Roots Engagement?" Science Communication 30: 305–327**

- Public education and communication strategies have been seen to fail in practical experiences.
- Yet the public is still expected by governments across the world to assume the responsibility for the response to climate change in many ways.

**Öhman, Johan, and Marie Öhman. 2013. "Participatory Approach in Practice: An Analysis of Student Discussions about Climate Change." Environmental Education Research 19 (3): 324–341**

- Work with deliberative conversations amount 16- 17-year-old students during the project suggested that a homogenous group of students may not reflect the full spectrum of perceptions or minority views on the subject.
- A teacher may be happy with students' agreement regarding the scientific consensus on climate change, but this would leave further work to be done helping them make sense of the controversy that requires others voicing valid concerns about issues such as economic choices, various mitigation scenarios.

**Ojala, M. (2012a). Hope and climate change: The importance of hope for environmental engagement among young people. Environmental Education Research, 18(5), 625–642.**

**Ojala, M. (2012b). Regulating worry, promoting hope: How do children, adolescents, and young adults cope with climate change? International Journal of Environmental & Science Education, 7 (4), 537–561.**

- Many students seem to share a positive attitude or trust in mitigation actions to stop climate change. Studies have shown again a high level of trust in secondary students.
- Students have most trust in scientists to accomplish climate change mitigation through invention of solutions and innovative technical solutions. Study considered global problems not only as a cognitive endeavor but also as an emotional experience and emotional coping strategies. These strategies are more important than the feelings themselves when it comes to influencing whether students will gain knowledge about climate change as well as acquire action competence. Educators would benefit from considering both emotions felt and the different emotion-regulating strategies used by young people.

**Ojala, M. 2015. "Hope in the Face of Climate Change: Associations with Environmental Engagement and Student Perceptions of Teachers' Emotion Communication Style and Future Orientation." The Journal of Environmental Education 46 (3): 133–148.**

- Supportive environment, perception of others' mental models and efficacy as well as strategies could aid in the building of individual sense of reasonableness and support. Explores the three factors of RPM (reasonable person model) and assess their ability to predict factors such as hopefulness.

**Ojala, M. 2007. "Hope and Worry: Exploring Young People's Values, Emotions, and Behavior Regarding Global Environmental Problems, Örebro Studies in Psychology 11." PHD diss., Örebro University.**

- Suggests the degree of concern for the environment varies in direct relation to hopefulness. Climate change concern was added as a mediator of hope based on these studies.
- Three main hypotheses (path model)
  1. Hope in students is more likely if there are able to make sense of information and believe that society as well as people have the ability to undertake the actions needed. They should also perceive there ARE actions to be taken to make a difference. If this is the case then model building, being effective and meaningful action are directly correlated to hope.
  2. If Environmental concern is used as a predictor that is associated with model building, being effective, and meaningful action, then it follows environmental concern will affect hope through these means.
  3. Combining constructs and demographic context variables can serve as a better prediction of hope about climate change than models simply containing the RPM constructs or demographic constructs alone.

**Olausson, U. 2011. "We're the Ones to Blame: Citizens' Representations of Climate Change and the Role of the Media." Environmental Communication 5: 281–299**

- Many studies have highlighted the decisive role of news media such as television, newspapers and the Internet in shaping public understanding of scientific issues by acting as bridges between scientists and the lay public.
- Analyses of news media framings of climate change have demonstrated differences in how climate change is described in different national contexts. For instance, in Sweden studies have identified a 'frame of certainty,' assuming that 'human-induced global warming is a direct cause of climate change, bringing with it dramatic consequences already at hand'.

**Patt, A., and D. Schrag. 2003. "Using Specific Language to Describe Risk and Probability." Climatic Change 61: 17–30.**

- people tend to overestimate the probability of relatively infrequent events [...] and underestimate the probability of relatively frequent events [...]

**Pettersson, A. (2014). "De som inte kan simma kommer nog att dö!" En studie om barns tankar och känslor rörande klimatförändringarna ["Those who can't swim will die!" A study of children's thoughts and feelings about climate change] (Licentiate thesis). Uppsala University, Uppsala.**

**Ojala, M. (2010). Barns känslor och tankar om klimatproblemen [Children's feelings and thoughts about the climate issue]. Eskilstuna: Energimyndigheten.**

- Other studies have shown the opposite, reporting low levels of worry
- Many students believe that government and international environmental organizations should share in the majority of the blame and responsibility for climate change.

**Poortinga, W., A. Spence, L. Whitmarsh, S. Capstick, and N. Pidgeon. 2011. "Uncertain Climate: An Investigation into Public Scepticism about Anthropogenic Climate Change." Global Environmental Change 21: 1015–1024**

**Whitmarsh, L. 2011. "Scepticism and Uncertainty about Climate Change: Dimensions, Determinants and Change over Time." Global Environmental Change 21: 690–700**

- There has been a growing decline in concern over climate change in the USA and the UK over the last few years.
- The public perceive climate change as being temporally and spatially remote as a risk.

**Poortinga, W., & Pidgeon, N. (2003). Public perceptions of risk, science and government: Main findings of a British survey of five risk cases. Norwich, UK: University of East Anglia, Centre for Environmental Risk**

- With an increased dependency on marketing gimmicks, "spin" and deceptive messaging in the media in general, there have come to be issues of trust regarding climate change communication. Because of this 'repeated uses of fear', these approaches may actually be damaging for organizations utilizing the tactics themselves.
- Argues trust is essential to communications sources and without trust communication effectiveness is at risk.
- UK individuals were found to be more likely to put trust in environmental organizations and scientists working for environmental groups/ universities but felt more uncertain about trusting local authorities, the national government and even the EU.

**Reser, J., G. Bradley, A. Glendon, M. Ellul, and R. Callaghan. 2012. Public Risk Perceptions, Understandings, and Responses to Climate Change and Natural Disasters in Australia and Great Britain. Gold Coast: National Climate Change Adaptation Research Facility**

- 71% of UK respondents were shown to be still very concerned about climate change, while other studies have shown that the number of people feeling claims about climate change and its impacts to have been exaggerated.

**Sadler, Tony D. 2011. "Situating Socio-scientific Issues in Classrooms as a Means of Achieving Goals of Science Education." In *Socio-scientific Issues in the Classroom: Teaching, Learning, and Research*, edited by Tony D. Sadler, 1–9. Vol. 39 of *Contemporary Trends and Issues in Science Education*. Dordrecht: Springer.**

- Teachers may find it helpful to start discussions with learners that question assumptions, while identifying values and comparing evidence then give room to explore perceptions.

**Seacrest, S., R. Kuzelka, and R. Leonard. 2000. "Global Climate Change and Public Perception: The Challenge of Translation'." Journal of the American Water Resources Association 36: 253–263**

- Scientists have studied for over a decade to determine the level of public understanding of climate change. (e.g. does the typical layperson understand or misunderstand climate change science) and it is

argued that generally people have a misunderstanding of the basic physical processes contributing to climate change.

**Schäfer, M. 2009. "From Public Understanding to Public Engagement. An Empirical Assessment of Changes in Science Coverage." *Science Communication* 30: 475–505.**

**Sturgis, P., and N. Allum. 2004. "Science in Society: Re-Evaluating the Deficit Model of Public Attitudes." *Public Understanding of Science* 13: 55–74.**

- Feel there is an implied shift of focus from the deficits present in peoples' scientific literacy to a model that is rooted in the idea of the situatedness of the public's understanding of science as well as the legitimacy of other knowledge found in science and policy processes.

**Schneider, R. O. 2011. "Climate Change: An Emergency Management Perspective." *Disaster Prevention and Management* 20: 53–62.**

- Climate change is recognized as being one of the greatest challenges faced by humanity today.

**Snyder, C. R. 1994. *The Psychology of Hope*. New York: Free Press.**

- There is an assumption that hopefulness is created through personal and collective efficacy (including personal and collective willpower/waypower to address climate change and the problems it brings about).

**Snyder, C. R., K. L. Rand, and D. R. Sigmon. 2002. "Hope Theory. A Member of the Positive Psychology Family." In *Handbook of Positive Psychology*, edited by C. R. Synder and S. J. Lopez, 257–275. New York: Oxford University Press**

- Items related to Hope Concerning Climate Change were based on The Trait Hope Scale in order to catch agency and pathways thinking on both a 3-item and 7-point agree and disagree scale.
- Individuals total score range is from 3 to 21 and again higher score indicates stronger hope.

**Snyder, C. R., L. M. Irving, and J. Anderson. 1991. "Hope and Health." In *Handbook of Social and Clinical Psychology: The Health Perspective*, edited by C. R. Snyder and D. R. Forsyth, 285–305. Elmsford, NY: Pergamon Press.**

- This worked to expand the hope construct and define it. The definition referred to it as being a cognitive construct which was composed of willpower (agency) and pathways thinking or way power toward goals. In this instance agency thinking is referring to the belief that you are capable of conceiving the means to meet the goal.

**Sterman, J. 2011. "Communicating Climate Change Risks in a Skeptical World." *Climatic Change* 108: 811–826.**

- Argues that 'where the dynamics of complex systems are conditioned by multiple feedbacks, time delays, accumulations and nonlinearities, mental models [...] often fail to account for these elements of dynamic complexity'. There is importance here in the aspect of identifying ways to improve science communication of the complex concepts to the media to help create actions based on 'the best scientific understanding'.

**Sterman, J., and L.B. Sweeney. 2002. "Cloudy Skies: Assessing Public Understanding of Global Warming." *System Dynamics Review* 18: 207–240.**

- During studies of peoples' understanding or misunderstanding of climate change, they argue that, based on an experimental study, people do not understand dynamics underlying climate change.
- Go further to state a mental model can be defined as: 'beliefs about the networks of causes and effects that describe how a system operates, along with the boundary of the model ... and the time horizon considered relevant'.

**Sundblad, E., A. Biel, and T. Gärling. 2008. "Knowledge and Confidence in Knowledge about Climate Change among Experts, Journalists, Politicians, and Laypersons." *Environment and Behaviour* 41: 281–302.**

**Uggla, Y. 2008. "Strategies to Create Risk Awareness and Legitimacy: The Swedish Climate Campaign." *Journal of Risk Research* 11: 719–734.**

- The majority of studies take their point of departure within the contexts of the USA or Britain and only a select few are undertaken elsewhere (particularly lacking are those of the developing world) or Britain.

**Swim, J. A., and J. Fraser. 2013. "Fostering Hope in Climate Change Educators." Journal of Museum Education 38 (3): 286–297.**

**Wuensch, K. L. 2015. An Introduction to Path Analysis. Accessed December 6, 2015**

- Informal Science educators' hope and engagement about climate change can be fostered through skills building combined with a socially supportive setting.

**Taber, F., & Taylor, N. (2009). Climate of concern – A search for effective strategies for teaching children about global warming. International Journal of Environmental and Science Education, 4 (2), 97–116.**

- Worry when combined with a trust in mitigation and the possibility of mitigating climate change actually may lead to high levels of motivation.

**Theobald, Elinore J., Alison Crowe, Janneke HilleRisLambers, Mary P. Wenderoth, and Scott Freeman. 2015. "Women Learn More from Local than Global Examples of the Biological Impacts of Climate Change." Frontiers in Ecology & the Environment 13 (3): 132–137**

- Direct test of the effect of a local example, reported that an undergraduate biology exercise helped students gain conceptual understanding with both local and global examples of climate changes.
- Found that female students learned more through local examples than global ones while males showed no geographical bias.
- Furthered that just linking climate change to its effect on people is not enough to cause deeper engagement with the issue.

**Tonn, B., Hemrick, A., & Conrad, F. (2006). Cognitive representations of the future: Survey results. Futures, 38, 810-829**

- Further added to the notion of individuals feeling removed from climate change and having the sense it would not affect them for many years by showing individuals have difficulty visualizing periods of time in the future - the study showed particularly that people had difficulty imagining passed 15-20 years into the future.

**Trench, B. 2008. "Towards an Analytical Framework of Science Communication Models." In Communicating Science in Social Contexts, edited by D. Cheng, M. Claessens, T. Gascoigne, J. Metcalfe, B. Schiele, and S. Chi. New York, NY: Springer.**

- While the practice of public understanding and that of public engagement approaches are not easily discernable and therefore separable they do tend to coexist.

**UNESCO (United Nations Educational, Scientific, and Cultural Organization). 1978. Final report.**

**Intergovernmental Conference on Environmental Education. ED/MD/49, United Nations Educational, Scientific, and Cultural Organization with United Nations Environment Program in Tbilisi, USSR, October 14–16, 1977 Paris, France: UNESCO**

- Points out the distinguishing between "just the facts" and "also the actions" can cause a divide between environmental educators. This may also serve to draw to light the point at which educators find science topic (a fundamental one) becomes too political and therefore more difficult or TOO difficult to teach.

**Ungar, S. 2000. "Knowledge, Ignorance and the Popular Culture: Climate Change Versus the Ozone Hole." Public Understanding of Science 9: 297–312.**

- Argues people's behaviours are governed by their mental models and that it has been found that laypeople tend to draw a line between global warming and other more conspicuous environmental problems such as ozone depletion.

**Volk, Trudi L., 1993. "Integration and Curriculum Design," in "Essential Readings in Environmental Education," edited by Dr. Harold Hungerford, 2005. Pp 141 – 160.**

- Dr. Volk considers students' developmental stages, showing where specific elements of environmental education should have major or minor emphasis in the classroom and in new curriculum. She emphasizes that environmental sensitivity and ecological foundations should dominate education in students' younger years (K-6), while issues, values, investigation, and action skills should dominate in students' later years (Grades 6-12):  
**Environmental sensitivity** refers to an empathetic view of the environment. Major emphasis from kindergarten to grade 3.  
**Ecological foundations** refer to having sufficient knowledge to make ecologically sound decisions. Major emphasis from kindergarten to grade 9.  
**Issues and values** refers to developing an understanding of environmental issues and the values and implications surrounding them. Major emphasis from grades 5 to 12.  
**Investigation and evaluation** refers to the knowledge and skills necessary to evaluate issues and solutions. Major emphasis in Grades 6 to 12.  
**Action skills** are those skills required to take positive environmental action. Major emphasis in Grades 6 to 12.

**Whitmarsh, L., G. Seyfang, and S. O'Neill. 2011. "Public Engagement with Carbon and Climate Change: To what Extent is the Public 'Carbon Capable'?" Global Environmental Change 21: 56–65.**

- There has been a shift in recent years towards the investigation of contextual meanings of science and how it applies to everyday life from seeing scientific literacy as being defined by the knowledge of abstract "facts".
- Argues that though climate change science has been heavily communicated in the public for over thirty years and the level of public knowledge has increased we have not seen much tangible change to people's behaviours and lifestyles.
- Offers ideas such as giving feedback on individual actions through tools such as online carbon calculators, comparisons of the relative contribution of different activities and how the individuals' lifestyle compares to others locally, nationally and globally.
- Some exploratory research points out that these types of tools could be successful in promoting the relevance of climate change in individuals who use them and therefore spur engagement.

**Wise, Sarah B. 2010. "Climate Change in the Classroom: Patterns, Motivations, and Barriers to Instruction among Colorado Science Teachers." Journal of Geoscience Education 58 (5): 297–309.**

- Teachers feel hesitation in teaching the topic of climate change as a response to parents' response to the subject.

**Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. Communication Monographs, 59, 329-349**

There are three pieces of the fear appeal.

1. Existence of threat (external stimulus variable exists whether the person knows it or not). When the threat is recognized (threat recognition) there are two more variables: severity of threat to the individual and the individual's susceptibility to the threat.
2. Emotion of fear itself. Recognition of the sense of impending danger and the emotion of pain or uneasiness that is caused. Notes the threat appeal needs to be recognized by the individual IF fear emotion is to be invoked.
3. Perceived efficacy of the response to the fear. (as in the fear that is felt by the individual). Two variables exist in the perceived response efficacy (does being afraid/ responding to the threat effectively prevent the threat?) and the perceived self-efficacy of the individual (Can I carry out this response?).

**Wolf, J., and S. Moser. 2011. "Individual Understandings, Perceptions, and Engagement with Climate Change: Insights from In-Depth Studies across the World." Wiley Interdisciplinary Reviews: Climate Change 2: 547–569**

- The same studies endorsing public engagement in science perspective are emphasizing that the goal of increased scientific literacy is not a sufficient one for climate change communication. Public engagement should mean the public is actively taking part in both learning and action on climate change and not just receivers of information. "engagement involves minds, hearts and hands".
- There is a need for the public to balance the problems of everyday life with social awareness of the problems that climate change gives rise to.

**Wynne, B., and U. Felt. 2007. Taking European Knowledge Society Seriously, Chair and Rapporteur, Expert Group on Science and Governance, Brussels, European Commission D-G Research (22700). EUR: Science Economy and Society Directorate.**

- Further states that beyond the implied shift in focus that distinction has been more openly discussed in general science literature. This literature has argued in favour of a transition from the approach of public understanding to one of public engagement.

**Zaksek, M., and J. L. Arvai. 2004. "Toward Improved Communication about Wildland Fire: Mental Models Research to Identify Information Needs for Natural Resource Management." Risk Analysis 24 (6): 1503–1514.**

- Suggests that both RPM and model building need for people to understand the issue to create a mental model to make sense of the world and therefore come to decisions. Both effective learning and sharing of information are ways to build models.

**Zimmerman, M. 1990. "Toward a Theory of Learned Hopefulness: A Structural Model Analysis of Participation and Empowerment." Journal of Research in Personality 24 (1): 71–86.**

- Hypothesizes that previous opportunities in forest management and involvement in the process will lead to more hopefulness as participation in organizations that are voluntary shows a direct relationship to hope.

## APPENDIX C: CORPORATIONS AGREE: CLIMATE CHANGE IS REAL, AND HUMAN-CAUSED

If climate change is a hoax, then why do all major Alberta energy companies have policies that address climate change? Here's a sample of their statements.



From Suncor's website: "As Canada's largest energy company... Suncor accepts the scientific consensus, publicly stating that 'climate change is happening and we need to take action.' Energy development has an impact on the environment and we must do our part to manage and minimize our carbon footprint."

<http://www.suncor.com/en-CA/sustainability/environment/climate-change>



"We recognize the significance of climate change, along with the role energy plays in helping people achieve and maintain a good quality of life. A key role for society – and for Shell – is to find ways to provide much more energy with less carbon dioxide."

<http://www.shell.com/sustainability/environment/climate-change.html>



"Meeting the world's energy needs while managing greenhouse gas (GHG) emissions is a complex challenge... With increasing oil and gas production, energy companies are focused on improving efficiencies and limiting emissions with innovative solutions and technology."

<https://www.encana.com/sustainability/>



"Husky recognizes the need to protect air quality... air quality is a regional issue. **Climate change**, however, is a global issue, and has been linked to human activity, fossil fuel consumption and the emissions of greenhouse gases."

<http://www.huskyenergy.com/environment/airstewardship.asp>



"As an energy company, Enbridge recognizes that we have a responsibility to address climate change [which] extends beyond compliance with regulatory requirements to include ... reducing our own carbon footprint as well as working with others to reduce GHG emissions across production, transportation and end use in the energy value chain as a whole."

[http://www.enbridge.com/~media/Enb/Documents/CSR/Policies/climate\\_change\\_policy.pdf](http://www.enbridge.com/~media/Enb/Documents/CSR/Policies/climate_change_policy.pdf)



"Four of Canada's largest oil sands producers have come together to demonstrate leadership on climate change. Canadian Natural Resources Limited, Cenovus Energy Inc., Shell Canada Limited and Suncor Energy Inc., support the Government of Alberta's climate plan related to the oil and natural gas industry, which includes a carbon pricing regime coupled with an overall emissions limit for the oil sands. These measures provide predictability and certainty and will help ensure that producers can responsibly develop and grow this significant Canadian resource while also addressing global concerns about climate change."

[http://www.cnrl.com/upload/media\\_element/974/03/1122\\_oil-sands-leadership-on-climate-change.pdf](http://www.cnrl.com/upload/media_element/974/03/1122_oil-sands-leadership-on-climate-change.pdf)