Preparing to Deliver Meaningful Climate Change Education to Secondary Students

Timothy Muhich

Students demand high-quality climate change course offerings

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Large numbers of Americans of all ages are interested in learning more about climate change education (CCE) (Perkins et al. 2017) and high schools have the opportunity to contribute to this learning. The Next Generation Science Standards (NGSS Lead States 2013) attempt to address climate change for high school students across disciplines. Despite the presence of climate change in NGSS, most high schools do not dedicate a class specifically to climate change or even to Earth Science. This leaves the burden of CCE to physics, chemistry, and biology classes, which often make space for it by mentioning the topic in ancillary form (Mousse et al. 2013).

While it should be common practice to talk about climate change throughout the curriculums (NGSS Lead States 2013), only addressing climate when it comes up in other classes results in students graduating high school still unable to articulate the causes or effects of climate change as well as what needs to be done to address the problem (Mousse, Ouarz, and Plate 2013; Reid 2019; Schirmer, Henthorn, and Kirkley Hanson 2009). Even if building climate change into other science classes was an effective strategy for teaching climate science, students would still not have gained climate literacy because CCE should also incorporate societal effects and climate justice (Stapleton 2019).

To leave students with applicable knowledge, CCE must be interdisciplinary. This allows students to address the most important questions—ones left out when CCE is just taught from an Earth Science perspective—such as “How might farmers adapt to changing climate conditions? How might such adaptations affect the price of staple foods, such as corn or wheat?” (Mousse, Ouarz, and Plate 2013). Many articles reference what CCE should do (Chang and Paczuski 2017; Monroe, Ouarz, and Plate 2013; Mousse et al. 2017; Reid 2019; Schirmer, Henthorn, and Kirkley Hanson 2009; Stapleton 2019). None of these lists can be accomplished in a single class (Supplementary Materials 1; see Online Connections). A stand-alone climate change course provides time for students to develop needed synthesis and skills and allows teachers in other classes to address climate change as it naturally comes up. In this case study, we provide evidence of that demand and propose a path for schools to deliver on it.

The study site

The Battle Creek Area Mathematics and Science Center (BCAMSC), a STEM school operated by Battle Creek Public Schools in Battle Creek, Michigan, began providing an interdisciplinary mini-course in climate change in 2006. Recognizing the impor-
How climate change is/should be taught in the US

- Americans are interested in learning more about climate change (Perkins et al., 2017)
- High schools have the opportunity to contribute to that learning.
- NGSS attempts to address climate change for students across disciplines (NGSS Lead States, 2013)
- Despite its presence in NGSS, most high schools do not dedicate a class specifically to climate change or even to Earth Science.
- This leaves the burden of CCE to physics, chemistry, and biology classes, which often make space for it by mentioning the topic in ancillary form (Monroe et al., 2013).
- Only addressing climate when it comes up in other classes results in students graduating high school still unable to articulate the causes or effects of climate change as well as what needs to be done to address the problem (Monroe et al., 2013; Reid 2019; Schreiner, et al., 2005).
- Even if building climate change into other science classes was an effective strategy for teaching climate science, students would still not have gained climate literacy because CCE should also incorporate societal effects and climate justice (Stapleton, 2019).
The features of high-quality CCE

• Leave students capable of engaging in climate change discourse (Chang and Pascua, 2017)
• Address mitigation and adaptation (Chang and Pascua, 2017)
• Increase adaptive and mitigation capacity of communities by helping students become able to make informed choices (Reid, 2019)
• It should be engaging and relevant (Monroe et al., 2017)
• Focus on impacts on human systems such as agriculture, health, extreme weather, infrastructure, and standard of living (Monroe et al., 2013; Stapleton, 2019)
• It must be interdisciplinary (Reid, 2019)
• It must address climate justice (Reid, 2019; Stapleton, 2019)
• It should empower students to act (Schreiner et al., 2005)
• Be project based and include active participation in the search for answers (Schreiner et al. 2005)
• It should not side-step emotion (Atkinson, 2022)
Climate Change and Michigan Forests

Welcome to Climate Change and Michigan Forests!

Please choose your curriculum.

New Wildfire and Climate Change Module for High School Teachers

By Kelly Steinberg

This spring (2022), Amherst is publishing a brand new education module for high school teachers in the Southwest. Climate Change and Energy impacts the world's forests, grasslands, and shrublands of the Southwest. Our research over five days, teachers and students build and burn model ecosystems, interpret and communicate data, and mitigation strategies.

Climate and Energy Educational Resource Collection

The CLEAN Collection is a high-quality and rigorously reviewed collection of climate and energy educational resources aligned with the Climate Literacy and Energy Literacy frameworks, and the Next Generation Science Standards.

Through peer-review, scientists and educators ensure scientific accuracy, pedagogic effectiveness, and classroom readiness for each resource.
The problem

• how to get school administration to encourage the teaching of climate change, which depending on the location of the school may be seen by administration as divisive (Howe et al., 2015), even though for the most part, teaching it is now supported in theory (NAAEE, 2023)

• by teachers who know little (Monroe et al., 2013) have had (and want) little training in the subject (Ennes et al., 2021),

• in a way that accurately and completely addresses climate science and justice (Stapleton, 2019),

• when many science teachers still try to shy away from discussing or taking any sides when it comes to climate change (Nation and Feldman, 2022).
## Options implementing meaningful CCE

<table>
<thead>
<tr>
<th>Integration of Climate Change Across the Curriculum</th>
<th>Implementation of Standalone Climate Change Course</th>
<th>Climate change as Part of an Extracurricular Activity</th>
</tr>
</thead>
</table>
| 1. Shows CC important and impacting all aspects of life  
2. Ensures exposure to concepts by all students | 1. Easy to implement  
2. Students gain coherent storyline  
3. Able to frame for student agency  
4. Only requires CK and PCK by one teacher in a school | 1. Much more freedom to do things that cannot be done in normal classes  
2. Allows an ability to focus |
| 1. CK and PCK needed by all teachers, this will require substantial PD  
2. Diffusion of responsibility  
3. Separation of impacts and solutions | 1. Potentially limits exposure to those already interested  
2. Limits scope of time to which student works in CC to one semester or one year | 1. Limits exposure to those privileged enough to participate in extracurriculars  
2. Relies upon |
Mental Health

• Do you think we are doomed: On its face it is not a feel-good story, happier not to think about
• How to make it uplifting: Solution focused CCE may be effective at reducing mental health concerns (Vergunst and Berry, 2021)
• It can be hard, when students care, they put in the work
• This is very easy to screw up, and a lot of environmental education has been harmful to students (Ray, 2020)
• Emotions must not be sidestepped or dismissed (Atkinson, 2022)
Creating Honors GCC

• “This class made me more aware of different things relating to climate change that I didn’t even know existed and I have learned a lot of things that I can share with other people so they can become involved in the change as well”

• “Last year I knew I wanted to make a difference in the world, to leave it better than I found it. This class helped me learn how, it honestly was so inspiring to be in a class where everyone cares so much about these problems. This class was the best one I have taken throughout all of my years in school, it was very relevant gave me the tools I needed to find what I truly want to do. I am so grateful that I was able to take this class.”

• “I thoroughly enjoyed the class and think a lot of people need this to be educated individuals in our communities and solve this growing problem.”

• “I think this class was hands down the most useful and important class I have taken in high school. Thank you for being so passionate about educating us on the climate crisis. I wish this class was longer :(

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Climate Change: An Inter-disciplinary Approach to Problem Solving (CLIMATE 480 // NRE 480)

Richard R. Reed
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http://climqr.engin.umich.edu/people/reed

Winter 2017
Class 1, January 5, 2017

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**Figure 1**
Student perceptions of class worth.

- a) Do you feel this class was useful?
- b) Are you glad you took this class?
- c) Would you recommend this class to a friend?
- d) Do you think other high schools should offer a class on climate change?
Creating Honors Global Climate Change

• Unit 1:
  • Understanding Climate and how it is changing

• Unit 2
  • Impacts of climate Change

• Unit 3
  • What to do about it
Climate Change 2022: Impacts, Adaptation and Vulnerability

The Working Group II contribution to the IPCC Sixth Assessment Report assesses the impacts of climate change, looking at ecosystems, biodiversity, and human communities at global and regional levels. It also reviews vulnerabilities and the capacities and limits of the natural world and human societies to adapt to climate change.
HGGC: Unit 1, Understanding climate and how it’s changing
HGGC: Unit 2, The impacts of climate change
HGGC: Unit 3, What to do about it

What will fill the electricity gap?
Example from California

- Solar energy peaks during the day.
- Natural gas is burned for the evening spike in demand.
- Wind helps, but not enough to offset gas.

Conventional nuclear is steady rather than responsive.

Sources of U.S. electricity generation, 2019

- Nuclear 20%
- Coal 23%
- Natural gas 38%
- Renewables 17%
- Petroleum 1%

Carbon Emissions
Per-capita by country

- Measuring the total carbon emissions data shows a dramatic increase in emissions across all countries, if first population isn’t considered.
- For example, even though China is the largest emitter of CO2, when measured in terms of per-capita emissions, China is not as significant as the US.

Underlying graph from the U.S. Energy Information Administration. Graphic by Karin Kilk for Yale Climate Connections.
HGGC: Accessing Curriculum

• Available through The Science Teacher (Muhich and Rood, 2022)
• Available through Gooru
• Available through tmuhich@umich.edu

• Needs refinement
• Needs tailoring
References