

# Learning Sciences Research Team

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[www.ClimateEdResearch.org](http://www.ClimateEdResearch.org);

[www.madeclear.org](http://www.madeclear.org)



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Viriden Center, 2013  
Academy  
Photo by Emily Hestness

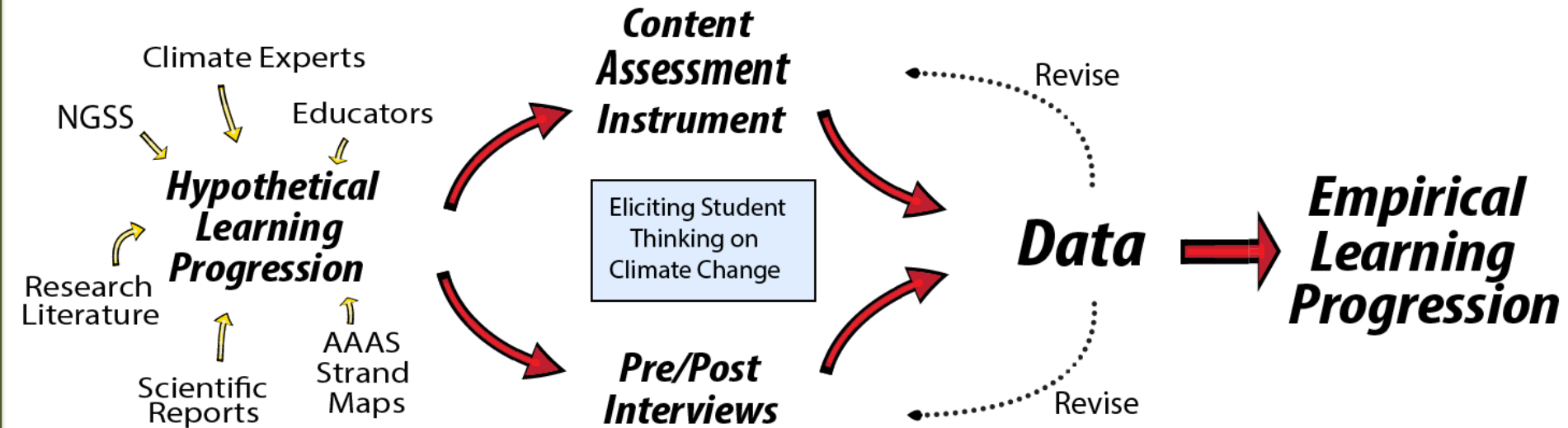
# Learning Progressions in the SIP

<b>3.1, 3.2</b>	Iterative development of climate change learning progressions	Learning progressions	<b>LS Workgroup,</b> UD, UMCP, UMCES	Years 1-4	Two Hypothetical LPs and Two Empirical LPs
<b>3.1, 3.2</b>	Collect and review data for learning progression and its application	Collected assessment/PD data	<b>LS Workgroup,</b> UD, UMCP, UMCES	Years 1-5	Research papers, Analysis of learning progression

# Climate Change Learning Progression: Overview

- Developed over five years with study participants from DE and MD.
- Builds on our previous LP work:
  - Sea Level Rise (Published in 2016; journal)
  - Extreme Weather (Published in 2017; book chapter)
  - Urban Heat Island Effect (Published in 2017, book chapter)

# Climate Change Learning Progression: Model



# Climate Change Learning Progression

## Human Activity

Level 1	Level 2	Level 3	Level 4
Students are able to explain that human activity is contributing to a warming earth. Students may state that human activity is producing gases or air pollution but they do not relate this to CO <sub>2</sub> or use of fossil fuels.	<p>Students are able to explain that human use of fossil fuels for energy generates CO<sub>2</sub> and is the primary cause of climate change.</p> <p>Students can explain that ozone and the ozone hole are not major factors in climate change.</p>	<p>Students are able to name specific fossil fuels used by humans (e.g. coal, oil, gas) and can distinguish between non-fossil fuel energy sources (nuclear, wind, solar).</p> <p>Students can describe that plants remove some of the human generated CO<sub>2</sub> from the atmosphere and may mention the basics of the carbon cycle (such as photosynthesis and respiration).</p>	<p>Students are able to describe the rate at which humans use fossil fuels for energy and the rate at which CO<sub>2</sub> is recaptured by oceans and vegetation. Students can describe the current imbalance between these two rates and the related impact on the carbon cycle.</p> <p>Students are aware of other GHG's generated by human activities.</p>

# Climate Change Learning Progression

## Mechanism

	Level 1	Level 2	Level 3	Level 4
Mechanism	Students are able to relate the presence of certain gases in the atmosphere to a warming earth but do not specify specific gases or the mechanism.	<p>Students are able to describe that greenhouse gases trap energy from the sun inside the earth's atmosphere causing the earth to warm and that CO<sub>2</sub> is primarily responsible for the enhanced greenhouse effect.</p> <p>Students acknowledge that excess CO<sub>2</sub> does not escape into outer space.</p>	Students are able to describe how energy from the sun reaches the earth's surface and is converted to heat energy and that some of the heat energy is absorbed by CO <sub>2</sub> and other GHGs that cannot escape into outer space and this energy is causing the earth to warm.	Students are able to provide a mechanism for the enhanced GHE at the molecular level. Students also can connect the mechanism to human use of fossil fuels and the current imbalance in the carbon cycle and elevated CO <sub>2</sub> concentrations. Students are also aware of positive feedback loops, such as albedo, that influence the mechanism.

# Climate Change Learning Progression

## Impacts

	<b>Level 1</b>	<b>Level 2</b>	<b>Level 3</b>	<b>Level 4</b>
Impacts	Students are able to explain that a warmer climate will affect humans and ecosystems but do not elaborate on specific impacts. They may confuse scientific certainty and projections with opinion and generally hold no realistic timeframe for climate change.	Students are able to identify local and global impacts of climate change and can provide specific examples. They state that scientists are relatively certain that climate change is happening now or will happen in the near future.	Students are able to describe local and global impacts of climate change and can provide examples of how these will vary geographically. They can explain that scientists use evidence from multiple sources and that climate change is happening now and is projected to increase in severity over time.	Students are able to describe local and global impacts of climate change. They can also explain that climate models are based on multiple sources of evidence and can list several sources. They understand that future impacts are based on scientific projections and may vary but the models are reliable and continue to improve with scientific research.

# Climate Change Learning Progression

## Mitigation and Adaptation

	Level 1	Level 2	Level 3	Level 4
Mitigation and Adaptation	Students are able to explain that simple actions individuals can take, such as conserving energy, can help slow climate change but cannot describe why. They can describe an action individuals can take to adapt to climate change.	Students are able to identify a limited number of actions individuals, communities, and countries can take to slow the rate of climate change or identify simple measures to adapt to the impacts of climate change.	Students are able to describe several possible mitigation and/or adaptation strategies to reduce the negative impacts of climate change. Students can also describe how these actions relate to the mechanism of climate change.	Students are able to identify several mitigation and adaptation strategies at the national and international levels that can slow rate of climate change. Students can compare and contrast each strategy as well as its cost, effectiveness, and regional relevance.



## Climate Change Learning Objectives

Students understand that human activities contribute to global warming on earth. Students understand that human activities produce greenhouse gases that contribute to global warming. Students understand that human activities produce air pollution that is related to global warming. Students understand that fossil fuels contribute to global warming.

Students understand that human activities use fossil fuels for energy, which produces CO<sub>2</sub> and other greenhouse gases. Students understand that human activities produce ozone and other air pollutants that are not related to climate change.

Students understand that human activities use fossil fuels for energy (nuclear, wind, solar, etc.) and that plants remove CO<sub>2</sub> from the atmosphere. Students understand that human activities produce greenhouse gases (such as methane) and that human activities produce air pollution (such as particulate matter).

### Level 4

Students are able to describe the rate at which humans use fossil fuels for energy and the rate at which CO<sub>2</sub> is recaptured by oceans and vegetation. Students can describe the current imbalance between these two rates and the related impact on the carbon cycle.

Students are aware of other GHG's generated by human activities.

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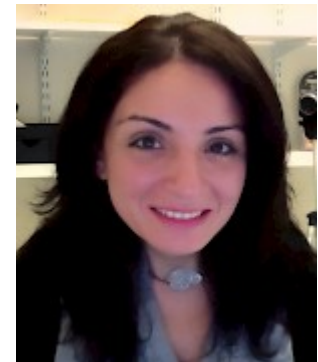
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# Learning Sciences Research Team



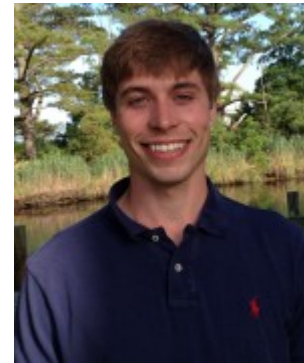
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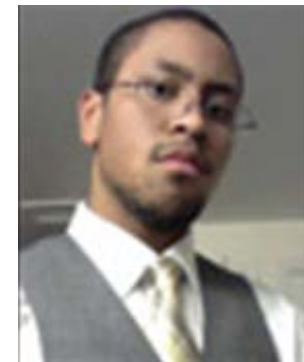
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