Learning Sciences Research Team

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www.ClimateEdResearch.org; www.madeclear.org

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<table>
<thead>
<tr>
<th>Learning Progressions in the SIP</th>
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<td><strong>3.1, 3.2</strong></td>
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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

Hypothetical Learning Progression

Content Assessment Instrument

Eliciting Student Thinking on Climate Change

Pre/Post Interviews

Data

Empirical Learning Progression

NGSS
Research Literature
Scientific Reports
Climate Experts
Educators
AAAS Strand Maps

Revise
Revise
# Climate Change Learning Progression

## Human Activity

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
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<tbody>
<tr>
<td>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 CO₂ or use of fossil fuels.</td>
<td>Students are able to explain that human use of fossil fuels for energy generates CO₂ and is the primary cause of climate change. Students can explain that ozone and the ozone hole are not major factors in climate change.</td>
<td>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). Students can describe that plants remove some of the human generated CO₂ from the atmosphere and may mention the basics of the carbon cycle (such as photosynthesis and respiration).</td>
<td>Students are able to describe the rate at which humans use fossil fuels for energy and the rate at which CO₂ 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.</td>
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## Climate Change Learning Progression

### Mechanism

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<tr>
<td>Mechanism</td>
<td>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.</td>
<td>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 CO₂ is primarily responsible for the enhanced greenhouse effect. Students acknowledge that excess CO₂ does not escape into outer space.</td>
<td>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 CO₂ and other GHGs that cannot escape into outer space and this energy is causing the earth to warm.</td>
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Climate Change Learning Progression

## Impacts

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<tr>
<td>Impacts</td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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# Mitigation and Adaptation

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<td><strong>Mitigation and Adaptation</strong></td>
<td>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.</td>
<td>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.</td>
<td>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.</td>
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Climate Change Learning Progression

Students are able to describe the rate at which humans use fossil fuels for energy and the rate at which CO₂ 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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