Today I Learned About Uncertainty

Description:

Earth's climate system is enormously complex, and scientists develop climate models to understand how climate change will play out in different parts of the world. Students play a climate resilience game, and then explore the Intergovernmental Panel on Climate Change's 5th Assessment Report to learn more about how climate scientists handle uncertainty in models.

Skills & Objectives

SWBAT

- Understand that scientists use multiple models to predict the future of Earth's climate.
- Explain the importance of agreed-upon language for uncertainty.
- Understand that specifics may be uncertain, even while the overall trend is very clear.

Skills

- Graph reading
- Close reading of scientific text
- Group communication

Students Should Already Know That

- Using high-powered computers and sophisticated software, scientists can model complex systems such as the climate or the human body.

Standards Alignment:
HS-ESS3-5 Analyze the results from global climate models.
RST.11-12.2 Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text.

Disciplinary Core Ideas:
ESS2.A Earth Materials and Systems
ESS2.D Weather and Climate
ESS3.C Human Impacts on Earth Systems

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How To Use These Activities:

Pages with the circular "TILclimate Guide for Educators" logo and dark band across the top are intended for educators. Simpler pages without the dark band across the top are meant for students.

Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

A Note About Printing

All student pages are designed to be printable in grayscale.

The worksheets do not leave space for students to answer questions. Students may answer these questions in whatever form is the norm for your classroom – a notebook, online form, or something else. This allows you, the teacher, to define what you consider a complete answer.

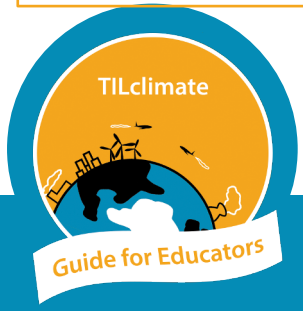
Beat the Uncertainty Game

This game was developed by the National Oceanic and Atmospheric Administration (NOAA) to model coastal climate resilience in a game. For each team of up to five players, you will need to print one checklist and booklet (found at the link below) as well as:

- One medium-to-large size clear container such as a straight-sided vase, food storage container, or similar.
- One smaller plastic container that sits upright, floats, and fits inside the larger container. Condiment containers or small plastic cups work well.
- About 15 glass floral beads (flat marbles.)
- Two six-sided dice
- (Optional) craft supplies to decorate your "city."

All instructions, booklets, and checklists can be found at https://games.noaa.gov/beat-the-uncertainty/welcome.html

Podcasts in the Classroom: Throughout these Guides for Educators, we invite students to think about how they would share their learning with family and friends. One way to do this is to encourage your students to create their own podcasts - they're shareable, creative, and have multiple options for embedded assessment. We would love to hear any podcasts or see any other projects you or your students create! Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.



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Detailed Table of Contents

Today I Learned About Uncertainty

Uncertainty, Modeling, and Decision-Making

This Educator Guide includes a game, readings, and a dive into the Intergovernmental Panel on Climate Change's 5th Assessment Report. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

Parts of this Guide may align with the following topics:

- Physical science: Climate and Earth System modeling, computer models
- Life/environmental science: Modeling, predictions, and climate impacts.
- History/social science: Decision-making, international agreements, and governance.
- ELA/nonfiction: Use of specific language in a scientific context.

MIT Resources

We recommend the following as resources for your own better understanding of climate change or as depth for student investigations. Specific sections are listed below:

- Climate Science, Risk & Solutions, an interactive introduction to the basics of climate change. https://climateprimer.mit.edu/
  - Chapter 02 The greenhouse effect and us
  - Chapter 06 Predicting climate
  - Chapter 07 Understanding risk
  - Chapter 09 How long can we wait to act?
  - Chapter 10 What can we do?
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. https://climate.mit.edu/explainers
  - The Intergovernmental Panel on Climate Change
  - Climate Models
  - Greenhouse Gases
  - Climate Sensitivity
  - Radiative Forcing
  - Climate Targets

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Wrap-Up Discussion Questions

- In the game, each outcome is a known roll of the dice – an exact probability. In the real world, are these events predictable to that level?
- Why is it important to include RCP8.5 and RCP2.6, even if they are both extremely unlikely to occur? (Consider adaptation and other future planning needs.)
- Why do you think it is important to have consistent language for confidence and likelihood in a report like the IPCC?
- How does uncertainty make it more complicated to create policies in response to climate change? To what degree should uncertainty and risk be considered? Does the existence of uncertainty make a scientific matter any less real or important to act on?

Climate Solutions

Climate solutions can be thought of as falling into four categories outlined below. Across all categories, solutions at the community, state or federal level are generally more impactful than individual actions. For example, policies that increase the nuclear, solar and wind mix in the electric grid are generally more effective at reducing climate pollution than asking homeowners to install solar panels. For more on talking about climate change in the classroom, see "How to Use This Guide".

- **Energy Shift**
  How do decision-makers make the switch from carbon-producing energy to carbon-neutral and carbon-negative energy?
- **Energy Efficiency**
  What products and technologies exist to increase energy efficiency, especially in heating and cooling buildings?
- **Adaptation**
  How can cities and towns adapt to the impacts of climate change?
- **Talk About It**
  Talking about climate change with friends and family can feel overwhelming. What is one thing you have learned that you could share to start a conversation?

What solutions are the most exciting in your classes? We would love to hear from you or your students! Images, video, or audio of student projects or questions are always welcome. Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.