INVENTING TOMORROW | LESSON PLANS

THE FUTURE IS BRIGHTER THAN YOU THINK

WATER MODULE

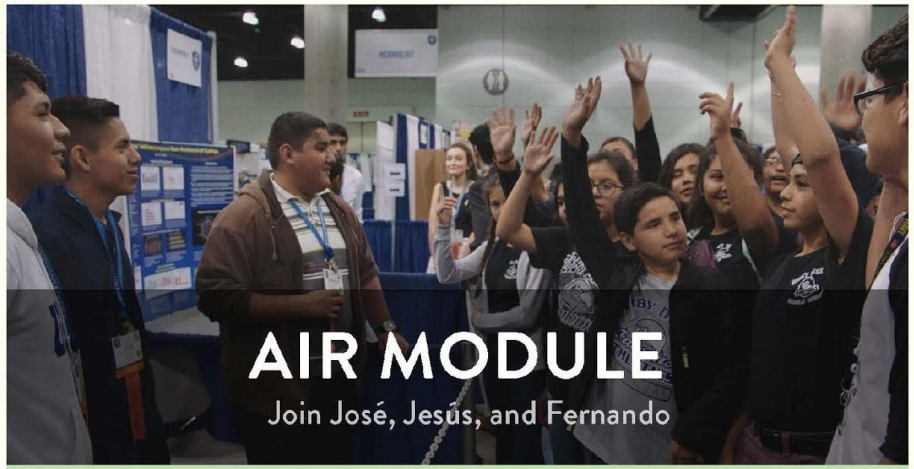
Explore Sahithi's Investigation

LESSONS

1. Sahithi's Story, and the Process of Science
2. What's Happening to Our Water?
3. Modeling Eutrophication with Understanding Global Change
4. Citizen Science: Water Data from Our Community
5. Connecting Water & Air: Sources of Pollution

DOWNLOAD ALL

SEE OVERVIEW >



AIR MODULE

Join José, Jesús, and Fernando

LESSONS

1. José, Jesús, and Fernando's Story, and the Process of Science
2. What's Happening to Our Air?
3. Modeling Air Pollution with Understanding Global Change
4. Citizen Science: Air Quality Data from Our Community
5. Connecting Air & Water: Pollution in Our Waterways

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INVENTING TOMORROW

THE FUTURE IS BRIGHTER THAN YOU THINK

These resources were designed to…

- Engage students in collaborative work, even during distance learning
- Allow students to observe young scientists at work and reflect on the nature of science
- Support the exploration of local environmental problems and participate in citizen science projects
- Develop student's ability to think about the Earth as an interconnected system

Next Generation Science Standards

These modules were designed to address the three dimensions of the middle and high school Next Generation Science Standards.

Science and Engineering Practices

The instructional practices used throughout these modules engage students in the process of science. Two practices are emphasized in these lessons:

Developing and Using Models
Students will develop and use a model based on evidence to describe a phenomenon and illustrate the relationships between components of a system.

Constructing Explanations and Designing Solutions
Students will gather, read, and synthesize information from multiple appropriate sources and construct an explanation between variables that predict phenomena.

Disciplinary Core Ideas

Middle School:

LS2.A: Interdependent Relationships in Ecosystems

- Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors.
- In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
- Growth of organisms and population increases are limited by access to resources.

ESS3.C: Human Impacts on Earth Systems

- Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things.

High School:

LS2.C: Ecosystem Dynamics, Functioning, and Resilience

- A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability.

ESS2.A: Earth Materials and Systems

- Earth's systems, being dynamic and interacting, cause feedback effects that can increase or decrease the original changes.

ESS3.C: Human Impacts on Earth Systems

- The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.

Crosscutting Concepts

Cause and Effect

- Students will use cause-and-effect relationships to explain and predict phenomena in Earth systems.

Systems and System Models

- Students will use models to represent systems and their interactions—such as inputs, processes, and outputs.

How can we engage students in the NGSS Science and Engineering Practices during distance learning and social distancing?

Which practices are you currently using?
Which practices are most challenging to address?

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating and communicating information

Please type responses in the chat!

What is an anchoring phenomenon?

A puzzling event or process whose full explanation requires a wide range of science ideas to be coordinated with one another and with evidence.

We can focus on learning about local environmental phenomena and understanding how to solve problems in our community.

In Traditional Group Tasks…

- Group gets assignment
- Group divides up tasks
- After each member of the group completes their parts, the group comes back together
- If a group grade will be assigned, most of the work is sometimes done by one person to make sure it is complete

Group *Worthy* Tasks

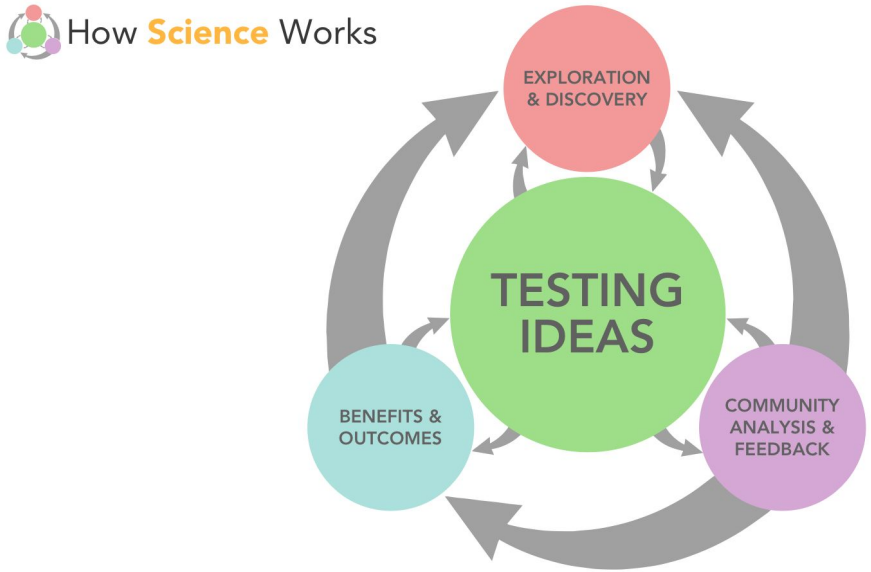
- Provide lots of opportunities for extensions and explorations
- Are 3-dimensional – (integrate SEPs, DCIs, CCCs)
- Require complex problem-solving
- Can not be completed without the contributions of all group members
- Both the entire group and individuals are accountable for the products

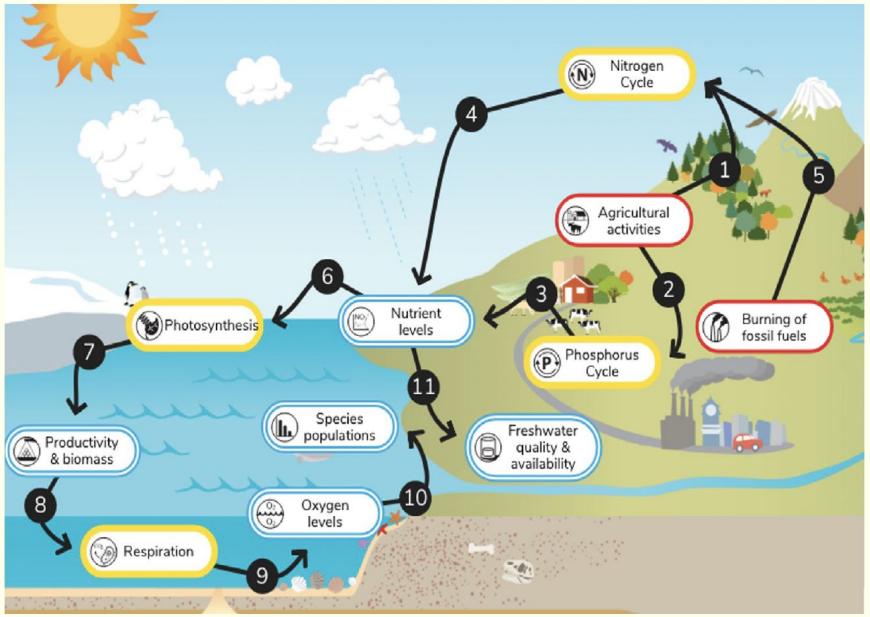
Tools for enhancing learning during social distancing

We will use these tools to explain **local environmental issues** and how to **solve problems** in our community.

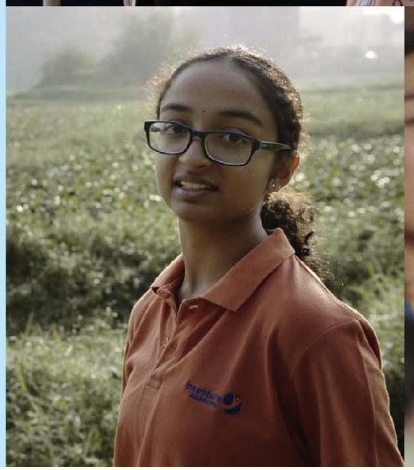
Jamboard

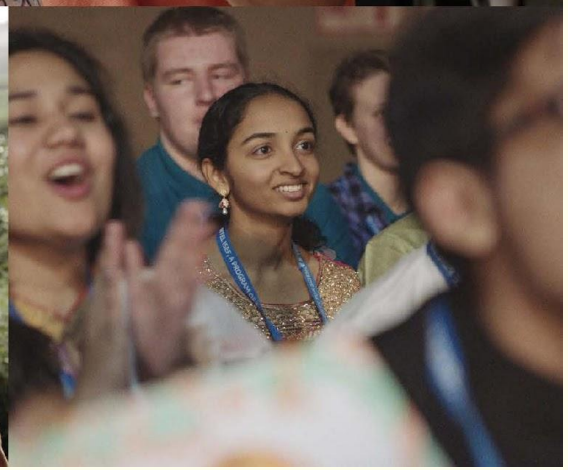
Visualize your ideas in a new and collaborative way





WATER MODULE OVERVIEW





LESSON 1

Sahithi's Story, and the Process of Science

Activity A

Investigating the Water in Your Community

Timing: 45 minutes
Purpose: Students examine evidence of changes (algal blooms) in their local fresh water environments using photos (or videos, news articles, or data, if available).

Activity B

Observing How Science Works: Sahithi's Journey

Timing: 45 minutes
Purpose: Students watch the short film about Sahithi's research and discuss the aspects of the scientific process they observe in the film.

Activity C

The Real Nature of Science

Timing: 45 minutes
Purpose: Students compare their models of the process of science to the Understanding Science, How Science Works Flowchart, and use the flowchart to document Sahithi's work.

LESSON 2

Sahithi's Investigation: What's happening to our water?

Activity A

Connecting Sahithi's research to a local phenomenon

Timing: 45 minutes
Purpose: Reintroduce the phenomenon of algal blooms (eutrophication) and have students will make an initial model of how and why this change in the environment occurs.

Activity B

Why does our water look like this? How do we solve this problem?

Timing: 45-90 minutes
Purpose: Students will learn about the causes and effects of, and solutions to, eutrophication and algal blooms in various parts of the United States, and compare this information to what they know about local waterways.

LESSON 3

Modeling Eutrophication with Understanding Global Change

Activity A

The Understanding Global Change Framework: Organizing Our Ideas for Model Revisions

Timing: 45 minutes
Purpose: Students will revisit their models and organize their ideas for revisions using the Understanding Global Change Framework.

Activity B

Constructing Models Using Understanding Global Change: Identifying Causes and Solutions

Timing: 45 minutes
Purpose: Students will revise their models using the Understanding Global Change modeling tools, and think about additional Earth system cause-and-effect relationships.

LESSON 4 (EXTENSION)

Citizen Science: Water Data from Our Community

Activity A

Collecting and Analyzing Water Data (with Sahithi's WaterInsights program or similar water testing-kits)

Timing: 45–120 minutes (the WaterInsights lessons are expected to take around 120 minutes)
Purpose: Students collect their own water samples and/or analyze existing datasets.

Activity B

Exploring Citizen Science Projects

Timing: 90 minutes or more
Purpose: Students will explore citizen science programs and construct an Earth system model that represents their understanding of the project. Students can then share their models with classmates and other community members to create awareness about a local environmental issue.

LESSON 5 (EXTENSION)

Connecting Water and Air: Sources of Pollution

Activity A

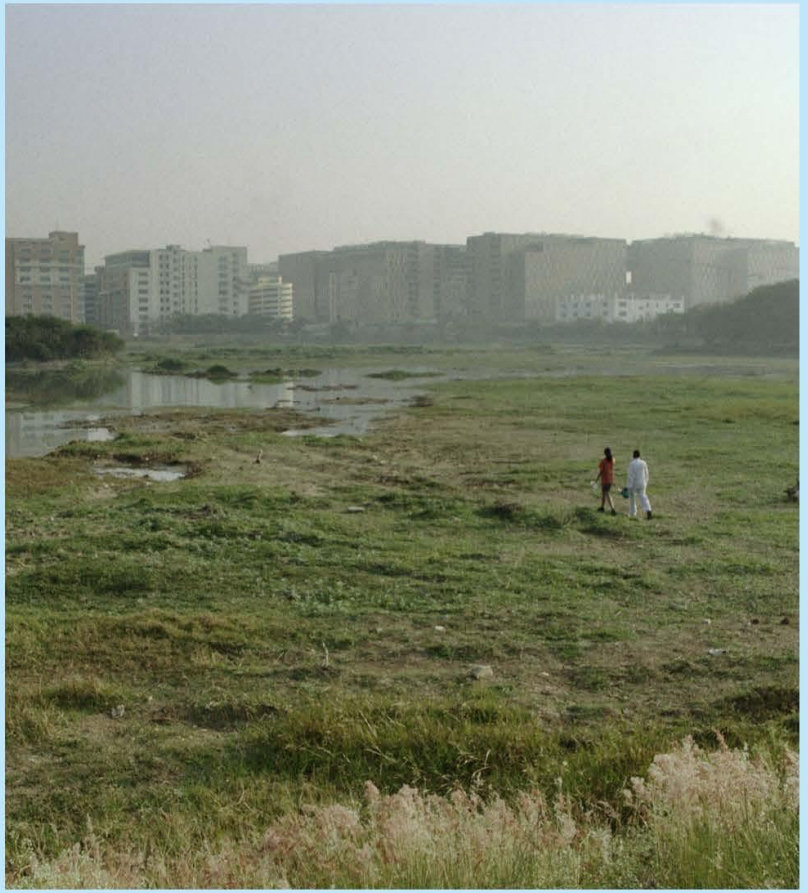
Sources of Water Pollution

Timing: 45 minutes
Purpose: Students will analyze charts that show sources of nitrogen pollution in major bodies of water (Great Lakes, Gulf of Mexico, etc.) and discuss sources of atmospheric pollution.

Activity B

Introducing José, Jesús, and Fernando: Designing solutions to reduce air pollution in Monterrey, Mexico

Timing: 45 minutes
Purpose: Students watch the short film about José, Jesús, and Fernando's research and discuss the dimensions of the scientific process they observe in the film, and add new information to their Understanding Global Change models.



AIR MODULE OVERVIEW

LESSON 1

José, Jesús, and Fernando's Story, and the Process of Science

Activity A

Investigating the Air Quality in Your Community

Timing: 45 minutes
Purpose: Students examine evidence of changes in air quality (smog) in their local environment using photos (or videos, news articles, or data, if available).

Activity B

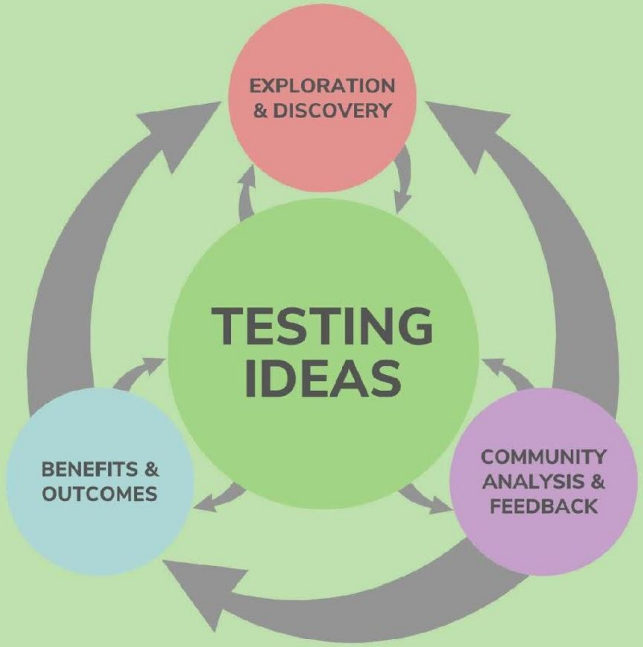
Observing How Science Works: José, Jesús, and Fernando's Journey

Timing: 45 minutes
Purpose: Students watch the short film about José, Jesús, and Fernando's research and discuss the aspects of the scientific process they observe in the film.

Activity C

The Real Nature of Science

Timing: 45 minutes
Purpose: Students compare their models of the process of science to the Understanding Science, How Science Works flowchart, and use the flowchart to document José, Jesús, and Fernando's work.



LESSON 2

José, Jesús, and Fernando's Investigation: What's happening to our air?

Activity A

Connecting José, Jesús, and Fernando's research to a local phenomenon

Timing: 45 minutes
Purpose: Reintroduce the phenomenon of smog, and students will make an initial model about how and why this change in the environment occurs.

Activity B

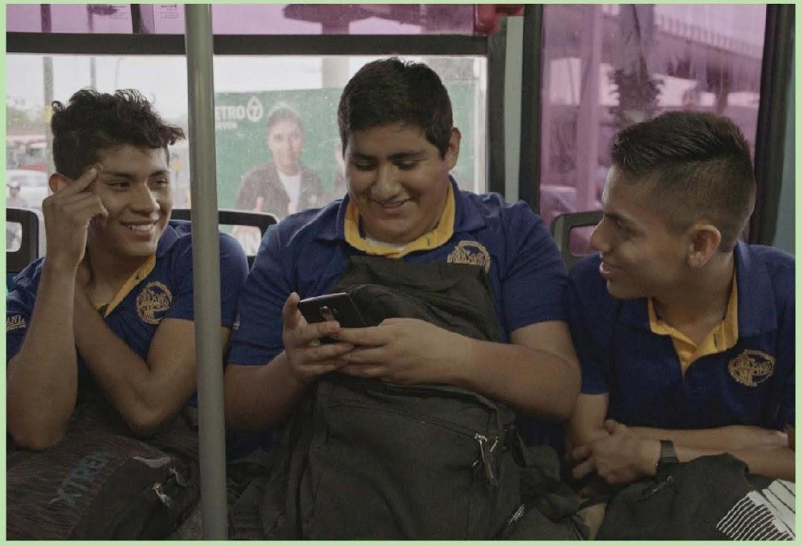
What's in our air?

Purpose: Students will be introduced to the major components of air pollution through a jigsaw activity and identify the sources and effects of various pollutants (including smog, acid rain, global warming, health/disease).

Activity C

Why is the world warming?

Purpose: Students will learn about how greenhouse gases re-radiate heat and how various factors (including aerosols, greenhouse gases, tropospheric ozone) influence Earth's average temperature.



LESSON 3

Modeling Air Pollution with Understanding Global Change

Activity A

The Understanding Global Change Framework: Organizing Our Ideas for Model Revisions

Timing: 45 minutes
Purpose: Students will revisit their models and organize their ideas for revisions using the Understanding Global Change framework.

Activity B

Constructing Models Using Understanding Global Change: Identifying Causes and Solutions

Timing: 45 minutes
Purpose: Students will revise their models using the Understanding Global Change modeling tools, and think about additional Earth system cause-and-effect relationships.

LESSON 4 (EXTENSION)

Citizen Science: Air Quality Data from Our Community

Activity A

Collecting and Analyzing Air Quality Data

Timing: 45–120 minutes or more
Purpose: Students collect their own data and/or analyze existing datasets.

Activity B

Exploring Citizen Science Projects

Timing: 90 minutes or more
Purpose: Students will explore citizen science programs and construct an Earth system model that represents their understanding of the project. Students can then share their models with classmates and other community members to create awareness about a local environmental issue.

LESSON 5 (EXTENSION)

Connecting Air and Water: Sources of Pollution

Activity A

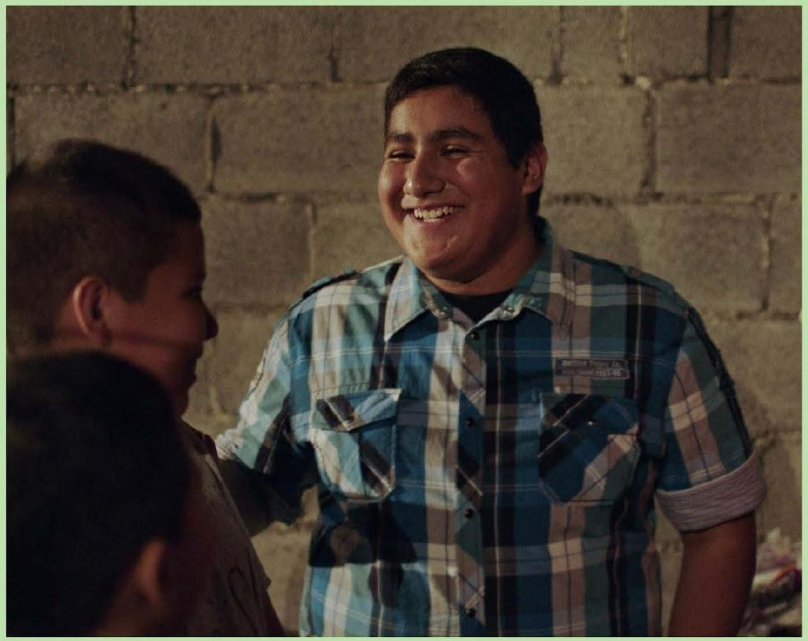
Sources of Water Pollution

Timing: 45 minutes
Purpose: Students will analyze charts that show sources of nitrogen pollution in major bodies of water (Great Lakes, Gulf of Mexico, etc.) and discuss sources of water pollution.

Activity B

Introducing Sahithi Pingali: Protecting Our Water

Timing: 45 minutes
Purpose: Students watch the short film about Sahithi's research and discuss the dimensions of the scientific process they observe in the film, and add new information to their Understanding Global Change models.



INVENTING TOMORROW

THE FUTURE IS BRIGHTER THAN YOU THINK

Lesson 1: Sahithi's Story and Process of Science

- **Activity A: Investigating the Water in Your Community**

Purpose: Students examine evidence of changes (algal blooms) in their local freshwater environments using photos (or videos, or data, if available).

- **Activity B: Observing How Science Works: Sahithi's Journey**

Purpose: Students watch the short film about Sahithi's research and discuss the aspects of the scientific process they observe in the film.

- **Activity C: The Real Nature of Science**

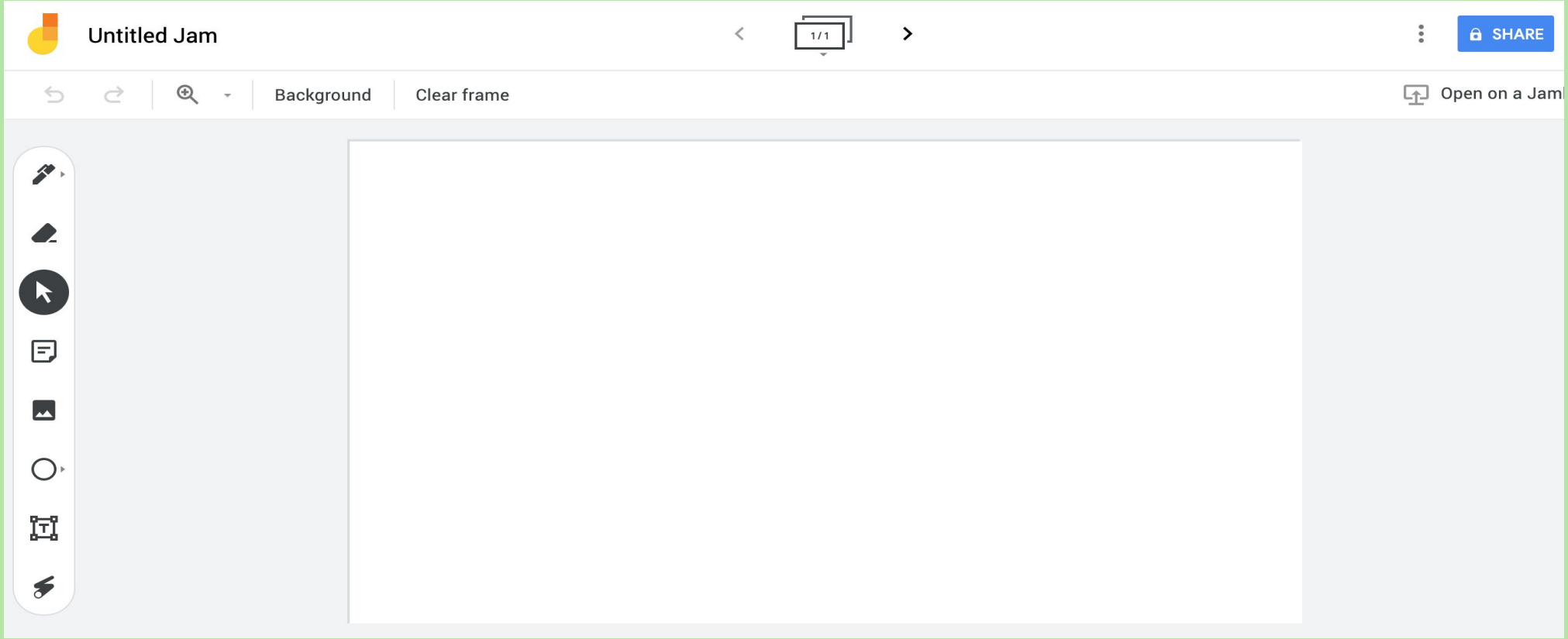
Purpose: Students compare their models of the process of science to the *Understanding Science* "How Science Works" flowchart, and use the flowchart to document Sahithi's work.

Lesson 1: Activity A

Investigating Water in Our Community

Now, you will make your ideas public on the Jamboard!

First, we need to learn how to use Jamboard…



Jamboard

Visualize your ideas in a new and collaborative way

During these lessons, we will become familiar with Jamboard, a digital whiteboard.

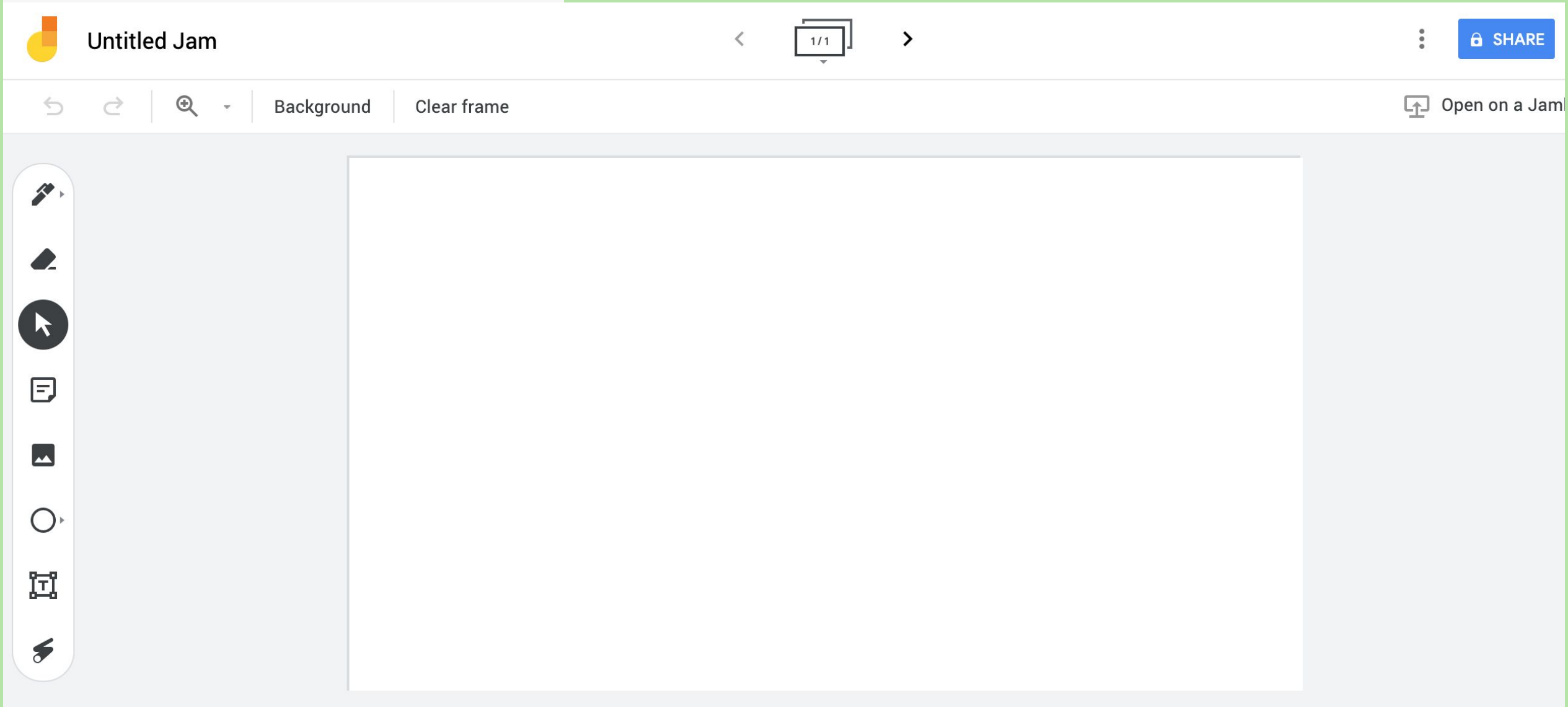
Jamboard allows you to:

- Collaborate with your classmates
- Share your work
- Save your work as images or pdfs

Jamboard

Visualize your ideas in a new and collaborative way

This is what a blank Jamboard looks like!

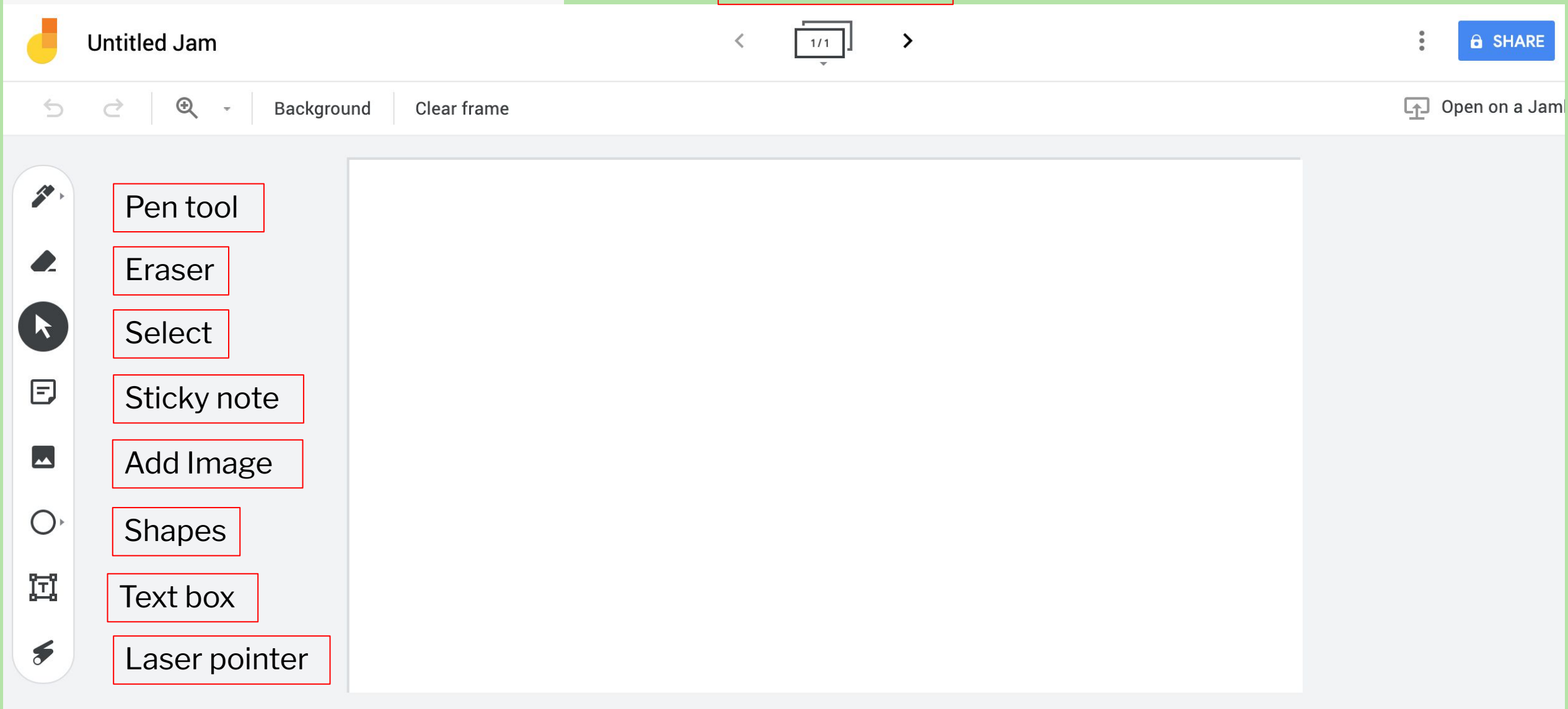


Jamboard

Visualize your ideas in a new and collaborative way

These are the tools...

Frame = Pages

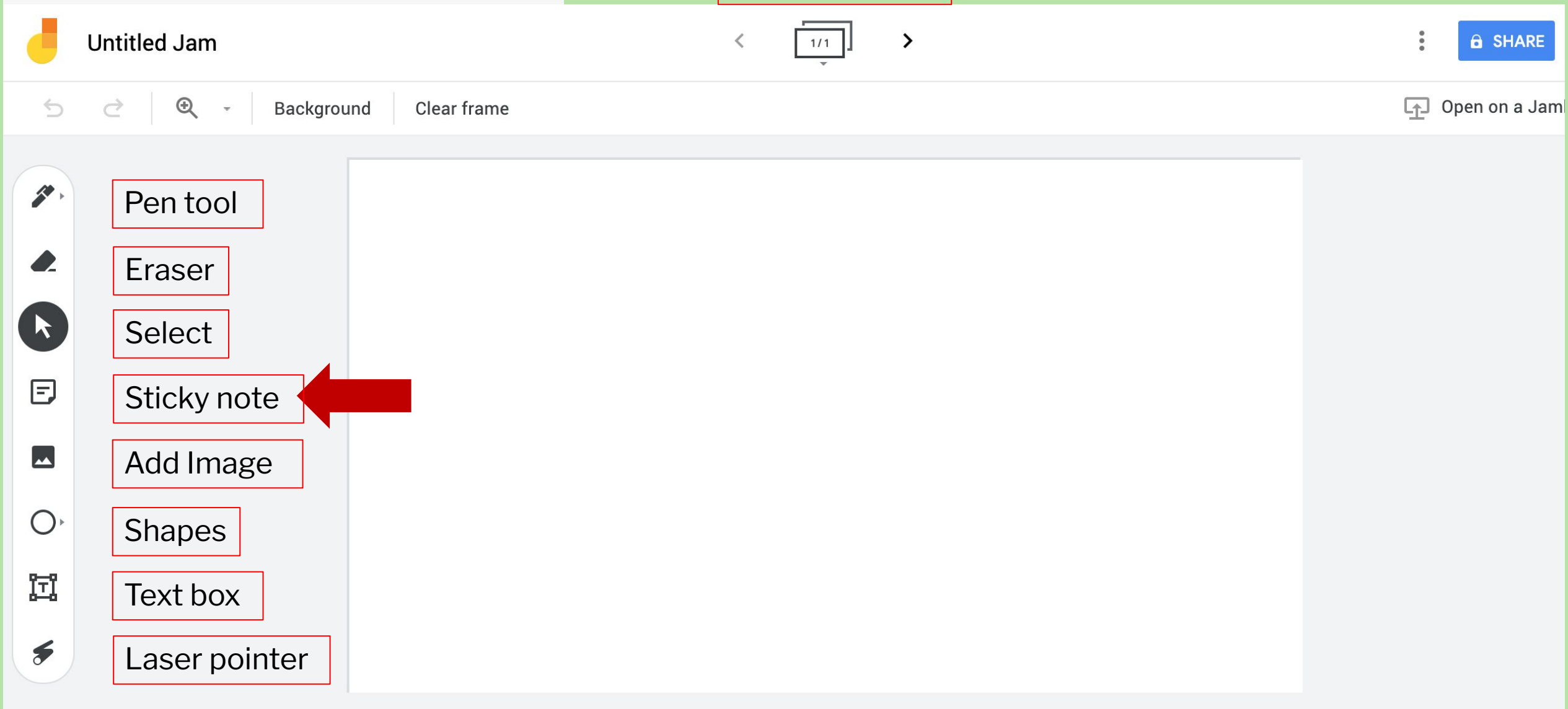


Jamboard

Visualize your ideas in a new and collaborative way

In this activity, we will make sticky notes.

Frame = Pages



Investigating Water in Our Community

Make your ideas public in the table (5 min)

- Use sticky notes to add your ideas under each question.
- There are no wrong answers!
- If you see a sticky with an idea similar to yours, try to place your sticky near that one.

What do you notice about this image?	What do you wonder about this image?	What does this image remind you of? Explain.	Would you drink this water? Swim or fish in this water? Explain.

Inventing Tomorrow Water Module

1 / 8

Set background | Clear frame

Click here to make a sticky note.

Investigating Water in Our Community

Make your ideas public on the Jamboard (10 min)

- Use sticky notes to add your ideas under each question.
- There are no wrong answers!
- If you see a sticky with an idea similar to yours, try to place your sticky near that one.

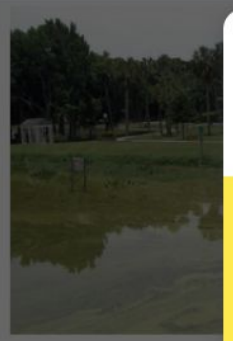
What do you notice about this image?	What do you wonder about this image?	What does this image remind you of? Explain.	Would you drink this water? Swim or fish in this water? Explain.

Inventing Tomorrow Water Module

1 / 1

Set background | Clear frame

Type in the box to share your ideas and hit "Save."



(10 min):

near that one.

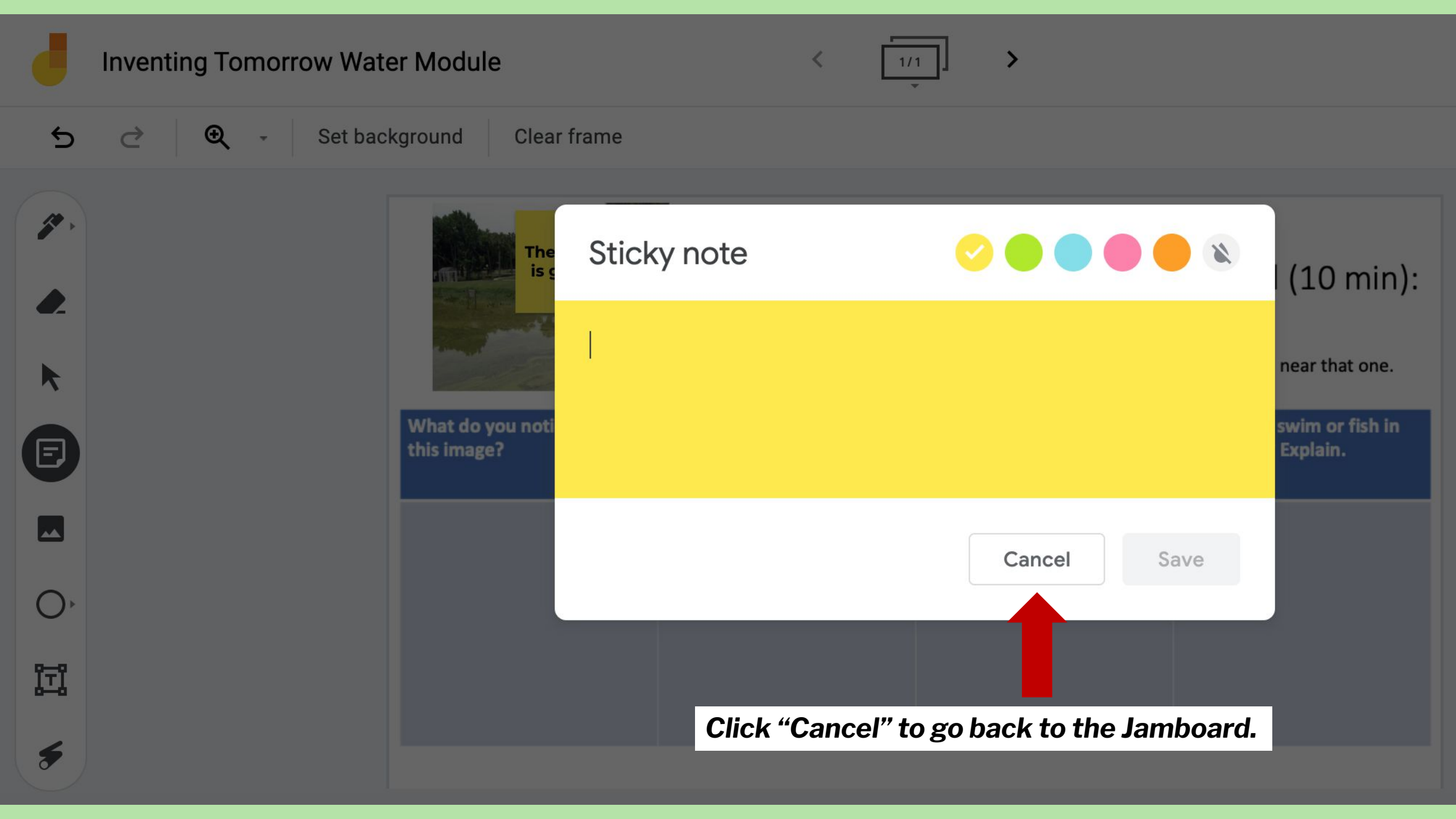
What do you noti
this image?

swim or fish in
Explain.

Sticky note

The water is green!

Cancel | Save


Inventing Tomorrow Water Module
1 / 1
Set background
Clear frame
Sticky note
Cancel
Save
Click “Cancel” to go back to the Jamboard.

Inventing Tomorrow Water Module

1 / 8

Set background | Clear frame

Your sticky will appear in the upper left corner.

Move the sticky to the space under the question you answered.

Investigating Water in Our Community
Make your ideas public on the Jamboard (10 min)

- Use sticky notes to add your ideas under each question.
- There are no wrong answers!
- If you see a sticky with an idea similar to yours, try to place your sticky near that one.

What do you notice about this image?	What do you wonder about this image?	What does this image remind you of? Explain.	Would you drink this water? Swim or fish in this water? Explain.

Inventing Tomorrow Water Module

1 / 8

Set background | Clear frame

Click here to make another sticky note!

Investigating Water in Our Community
Make your ideas public on the Jamboard (10 min)

- Use sticky notes to add your ideas under each question.
- There are no wrong answers!
- If you see a sticky with an idea similar to yours, try to place your sticky near that one.

What do you notice about this image?	What do you wonder about this image?	What does this image remind you of? Explain.	Would you drink this water? Swim or fish in this water? Explain.
The water is green!			

Investigating Water in Our Community

Let's review our poster and have a class discussion (3 min)

- Did you have any similar ideas? Are they grouped together on the poster?
- Are any of the ideas shared surprising? Why?

What do you notice about this image?	What do you wonder about this image?	What does this image remind you of? Explain.	Would you drink this water? Swim or fish in this water? Explain.

Investigating Water in Our Community

We will watch a short film about a young scientist, Sahithi Pingali, working to understand a similar problem in her community. Note: If your students will also be participating in collecting data for, or interpreting data from WaterInsights, share this with your students!

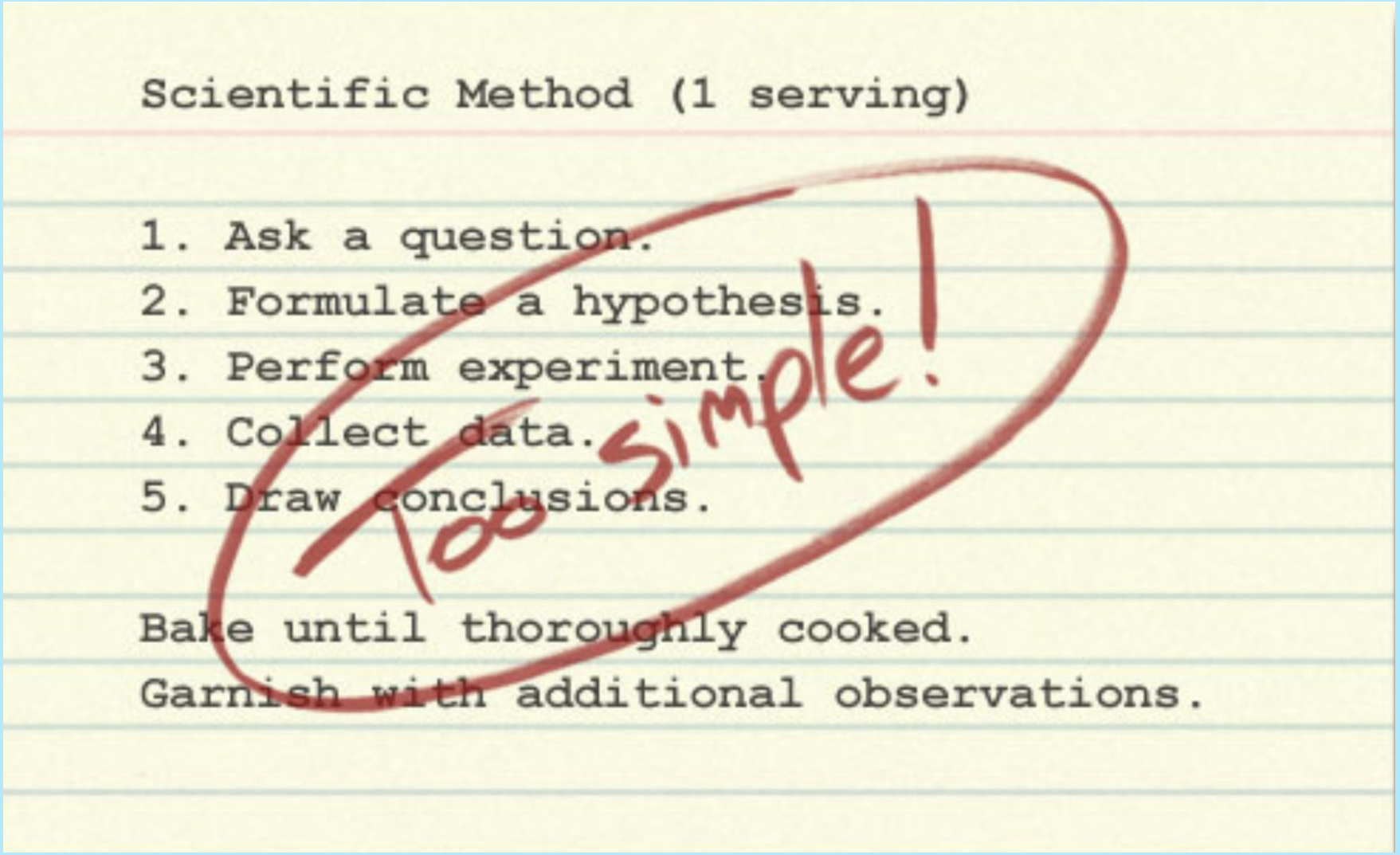
Lesson 1: Activity C

How can science help us explain and respond to what is happening to our water?

What are the parts of the process of science?

On your own paper, write down your ideas (2 min)

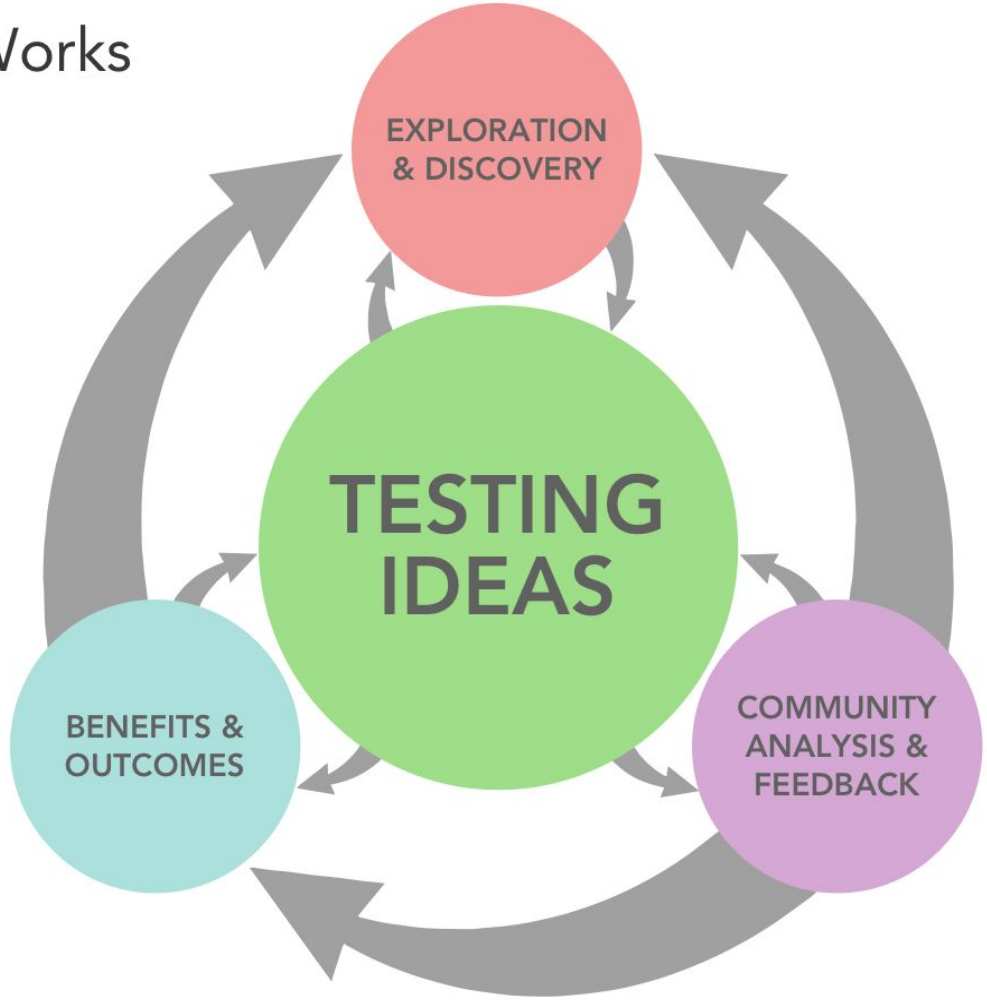
“The Scientific Method”



https://undsci.berkeley.edu/article/0_0_0/howscienceworks_01

Let's see how our models compare to another diagram of the process of science!

How Science Works



How Science Works

Exploration & Discovery

Curiosity

Practical problem

Making observations

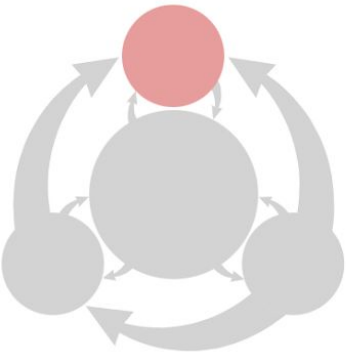
Asking questions

Sharing data and ideas

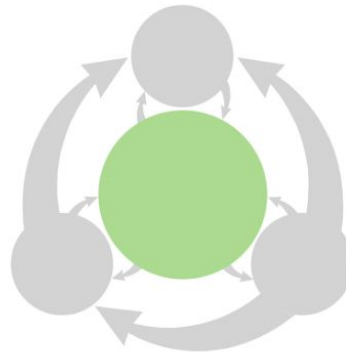
Reading about science discoveries

New observation or idea

Pure chance

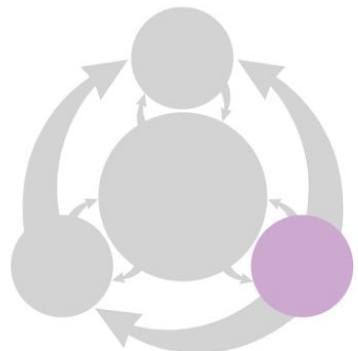


Testing Ideas

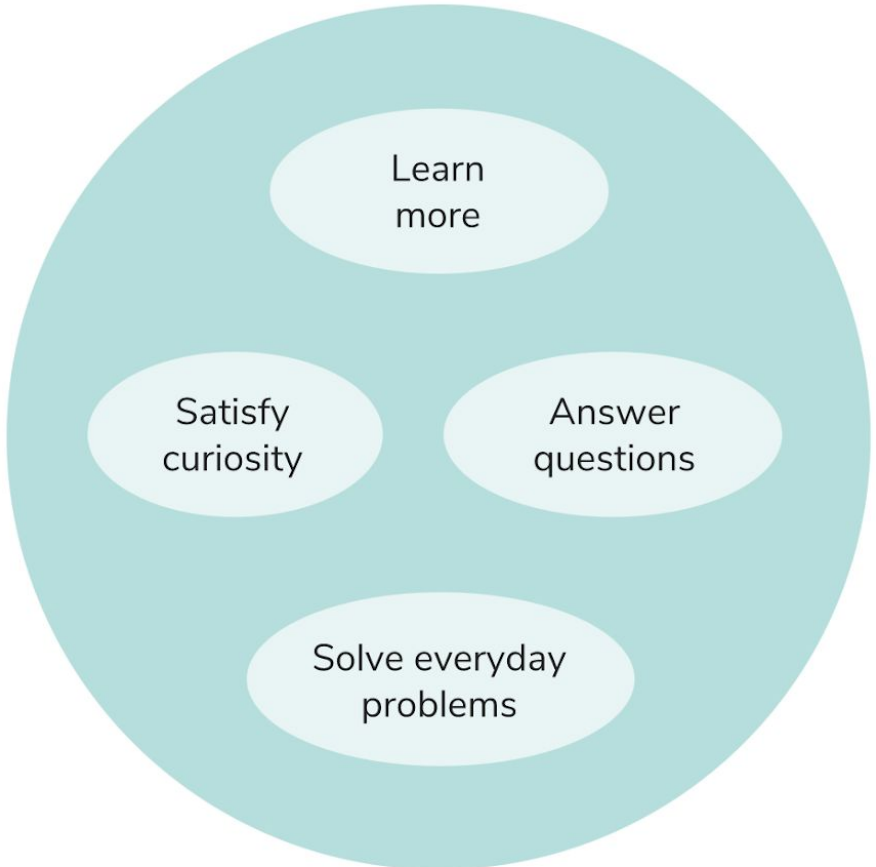


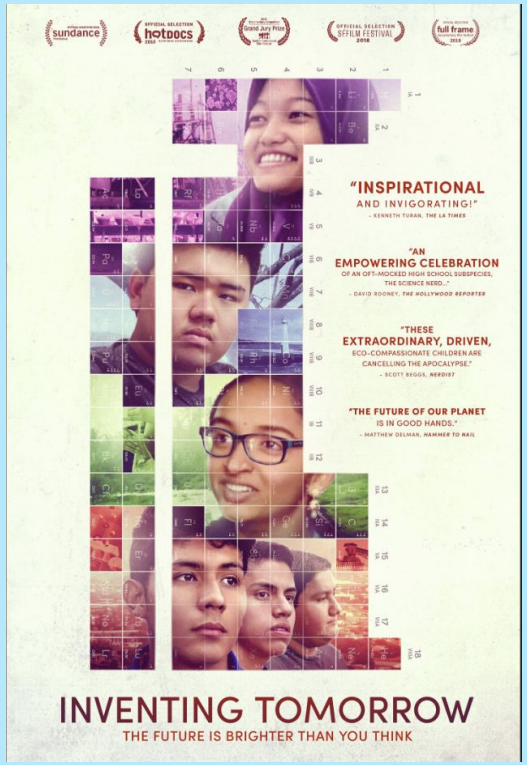
How Science Works

Community Analysis and Feedback



Benefits and Outcomes





We are going to further our thinking about the process of science by observing the work of high school scientist, Sahithi Pingali!

As you follow Sahithi's story, note the parts of the scientific process that you observe in the film.

Inventing Tomorrow Workshop Jamboard Template - Amba...

2 / 8

Set background | Clear frame

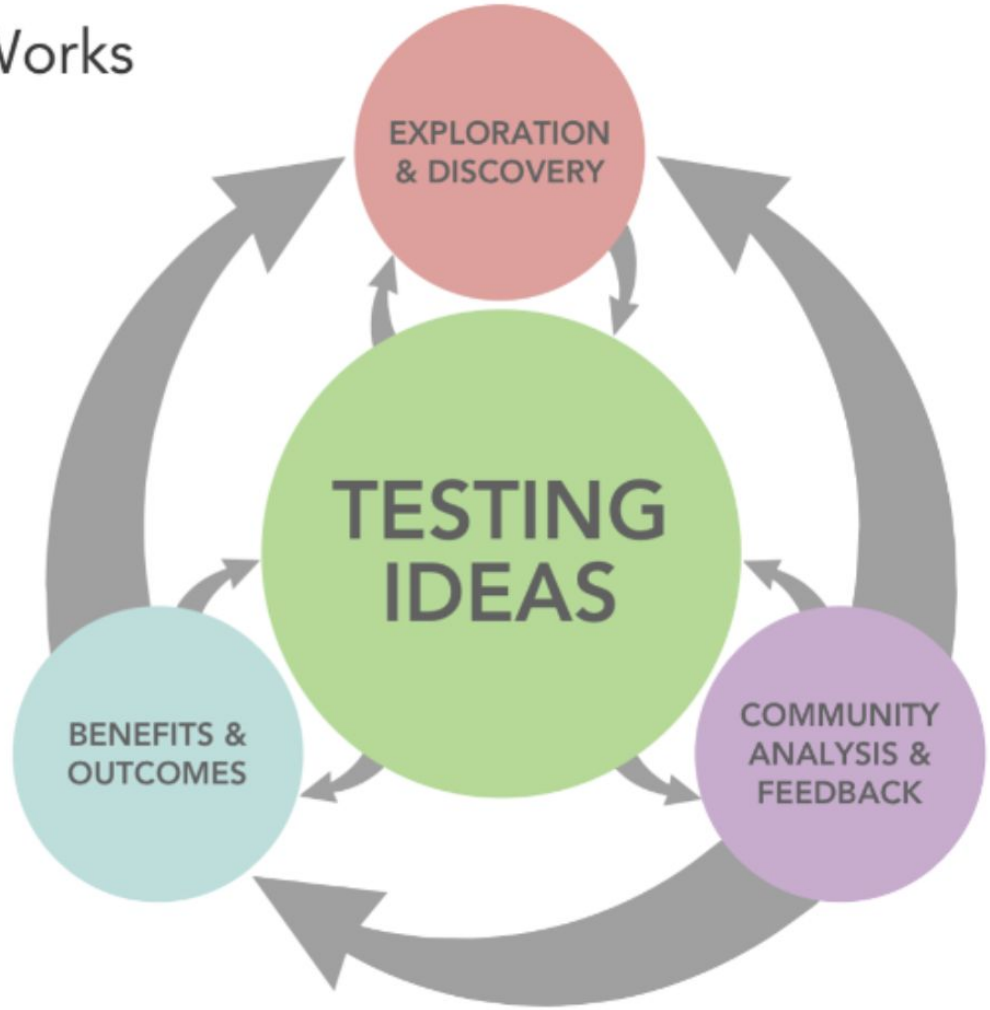
Group 1

How Science Works

Identify what parts of the process of science we saw Sahithi engage in during the film.

Use stickies to explain each step you identify.

Connect the steps with arrows, but don't worry too much if you think they are out of order, just make sure you identify all the parts relevant to their story.

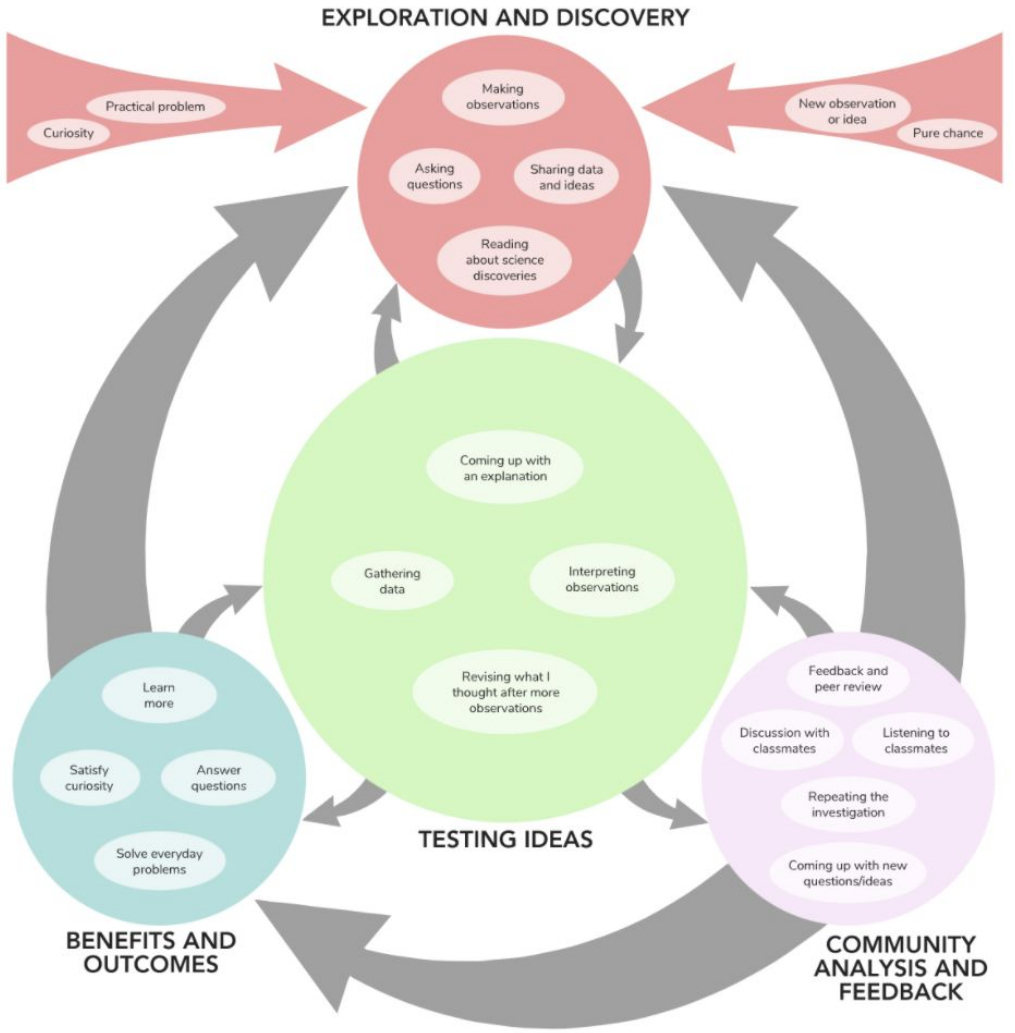


Working in breakout rooms

Identify what parts of the process of science we saw Sahithi engage in during the film.

Use stickies to explain each step you identify.

Connect the steps with arrows, but don't worry too much if you think they are out of order, just make sure you identify all the parts relevant to their story.

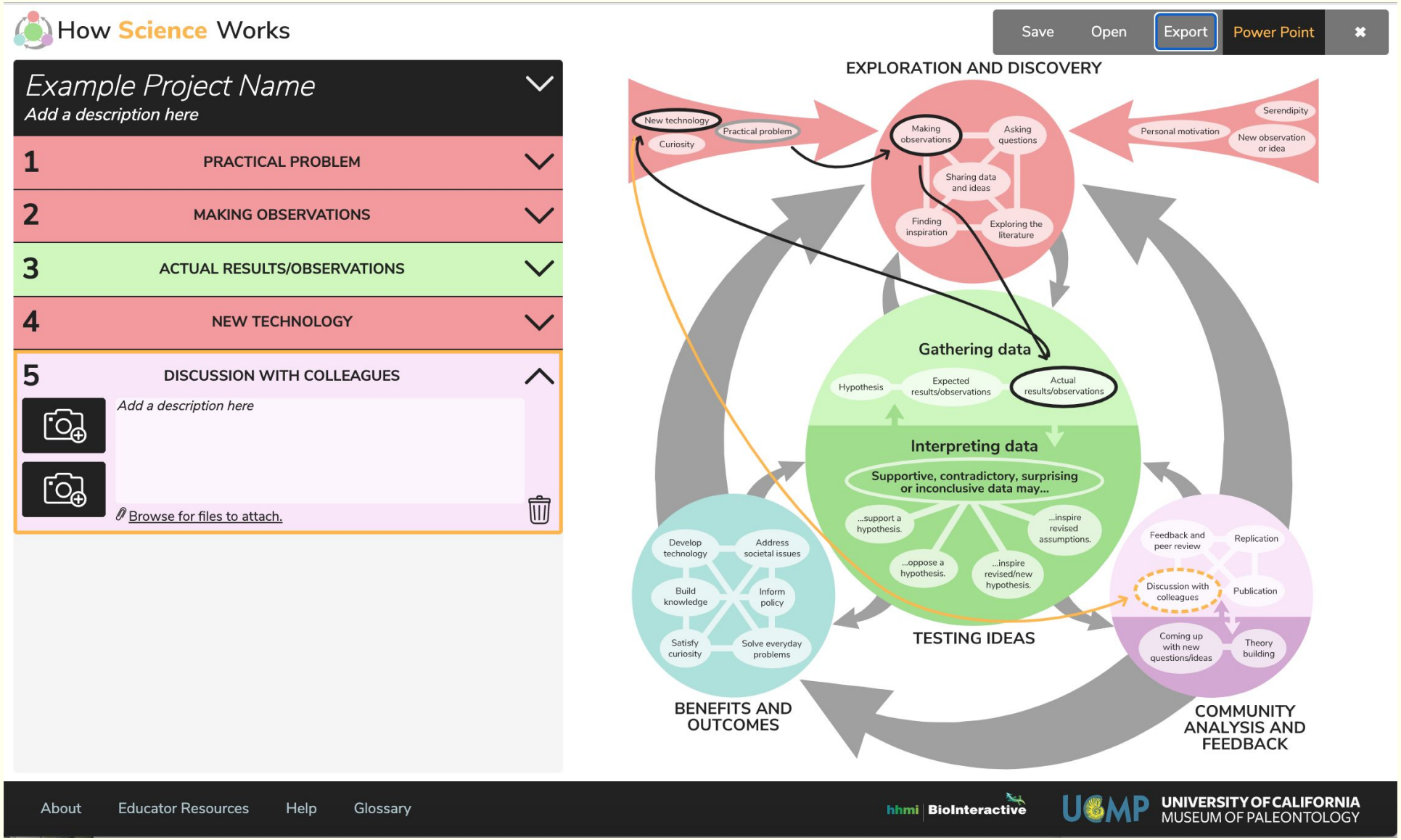


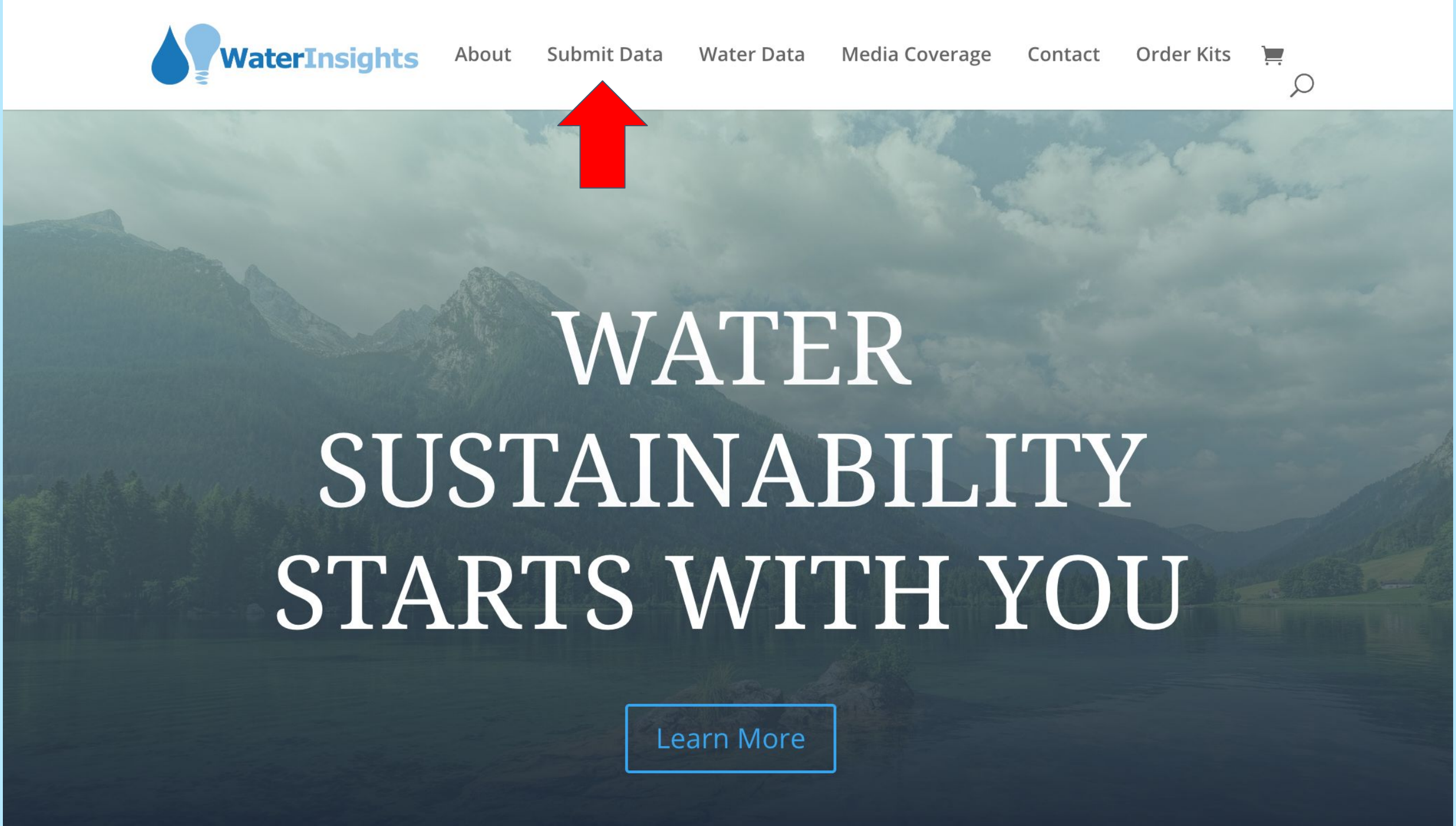
Working in breakout rooms

Follow-up Question

What inspired Sahithi’s work? Briefly summarize how her scientific journey started.

How Science Works Interactive




WaterInsights
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Submit Data
Water Data
Media Coverage
Contact
Order Kits
WATER
SUSTAINABILITY
STARTS WITH YOU
Learn More


FRESHWATER COMPARISON CHART
NITRATE (NO3) ppm (mg/L) - FRESHWATER
Safe
Unsafe
NITRITE (NO2) ppm (mg/L) - FRESHWATER
Safe
Caution
Stress
Danger
TOTAL HARDNESS (GH) ppm - FRESHWATER
Very Soft
Soft
Hard
Very Hard
TOTAL CHLORINE ppm - (mg/L) - FRESHWATER
Safe
Danger
TOTAL ALKALINITY (KH) ppm - FRESHWATER
Low
Moderate
Ideal
High
pH - FRESHWATER
Acidic
Neutral
Alkaline
WaterInsights
Introduction to our Classroom Kit
Thank you for your interest in testing your community's water!
I created WaterInsights when I learned – and experienced firsthand in my own community – just how contaminated the world's water is. For instance, 40% of lakes in the United States are too polluted for fishing, swimming, or aquatic life. And 80% of surface water in India, where I was raised, is contaminated, which leads to numerous health problems and a scarcity of drinking

Submit Data

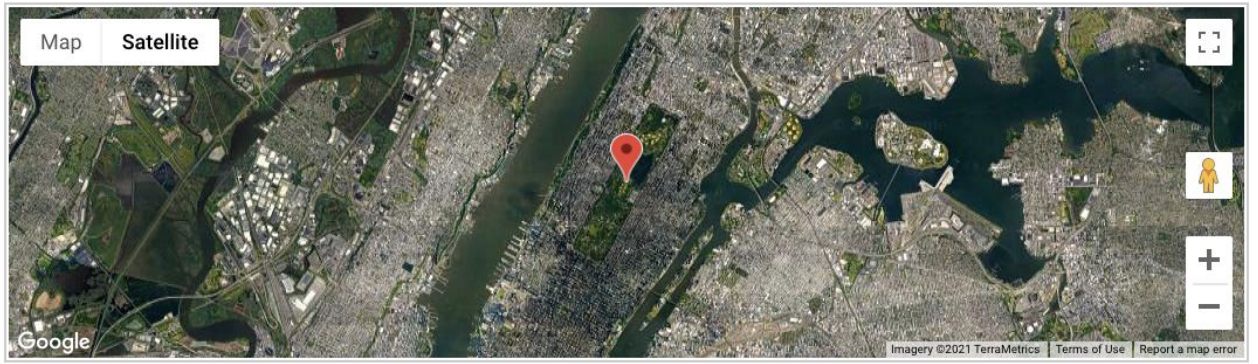
Submit data using your WaterInsights Testing Kit.

Here's how it works:

Gather a water sample in a container you'd be comfortable drinking from. To test your water sample, you'll need to sub
water for about 1 second. Take it out, start a timer for 30 seconds (your watch or smart phone might have one), and pla

When the timer ends, you can use the enclosed analog color bar card to read the values for each of the 6 color blocks. U
data to our application. We'll analyze that data and tell you about your water quality. We'll also store your data with oth
we can study trends in water bodies worlwide! You will be contributing to a World Water Health Map!

Map



Coordinates

Latitude | longitude

Any Other Observations?

What Type of Water are You Testing?

Tap Water

Nitrate Value

0 PPM

Nitrite Value

0 PPM

Hardness Value

0 PPM

Chlorine Value

0 PPM

Alkalinity Value

0 PPM

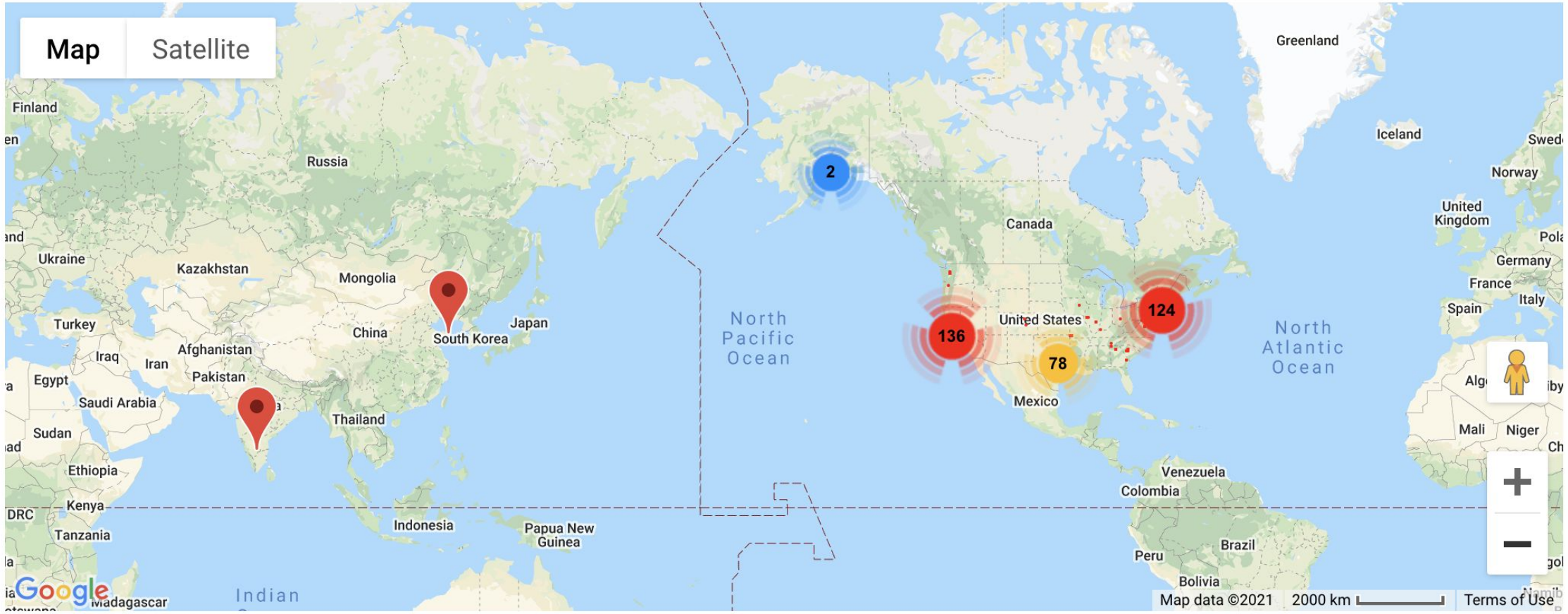
pH Value

6.2

Map of locations.

Below is a map of the data from other citizen scientists. Submit your own data and join the map!

These data are periodically vetted, but are publicly generated, and WaterInsights cannot verify the accuracy of the measurements and data reported.



Inventing Tomorrow: Air Module, Lesson 3

INVENTING TOMORROW
THE FUTURE IS BRIGHTER THAN YOU THINK

INVENTING TOMORROW

THE FUTURE IS BRIGHTER THAN YOU THINK

Lesson 3: Air Pollution Modeling and Understanding Global Change

- **Activity A: The Understanding Global Change Framework: Organizing Our Ideas for Model Revisions**

  Purpose: Students will revisit their models and organize their ideas for revisions using the "Understanding Global Change" framework

- **Activity B: Constructing Models Using Understanding Global Change: Identifying Causes and Solutions**

  Purpose: Students will revise their models using the Understanding Global Change modeling tools and think about additional Earth system cause and effect relationships.

Systems Thinking

As you work on your model, you are using systems thinking.

You are identifying:

- **Components of the system** – the parts of the environment that help you explain air pollution and smog
- **Interactions** – how parts of the systems are connected

Construct a model to make your thinking visible

You will have 5 minutes to construct a model using the icons, arrows, and words that explains what you know about air pollution.

- Make sure all the icons are connected to at least one other icon
- You can draw arrows using the pen tool (hold the shift key down to draw a straight line)
- Provide and explanation for each of the connections using yellow sticky notes
- Write down any questions you have on pink sticky notes

Inventing Tomorrow Workshop Jamboard Template

3 / 3

Set background | Clear frame

Group 1

- Burning of fossil fuels
- Urbanization
- Greenhouse effect
- Airborne particles
- Air quality
- Air temperature
- Health

You will have 5 minutes to construct a model using the icons, arrows, and words that explains what you know about air pollution.

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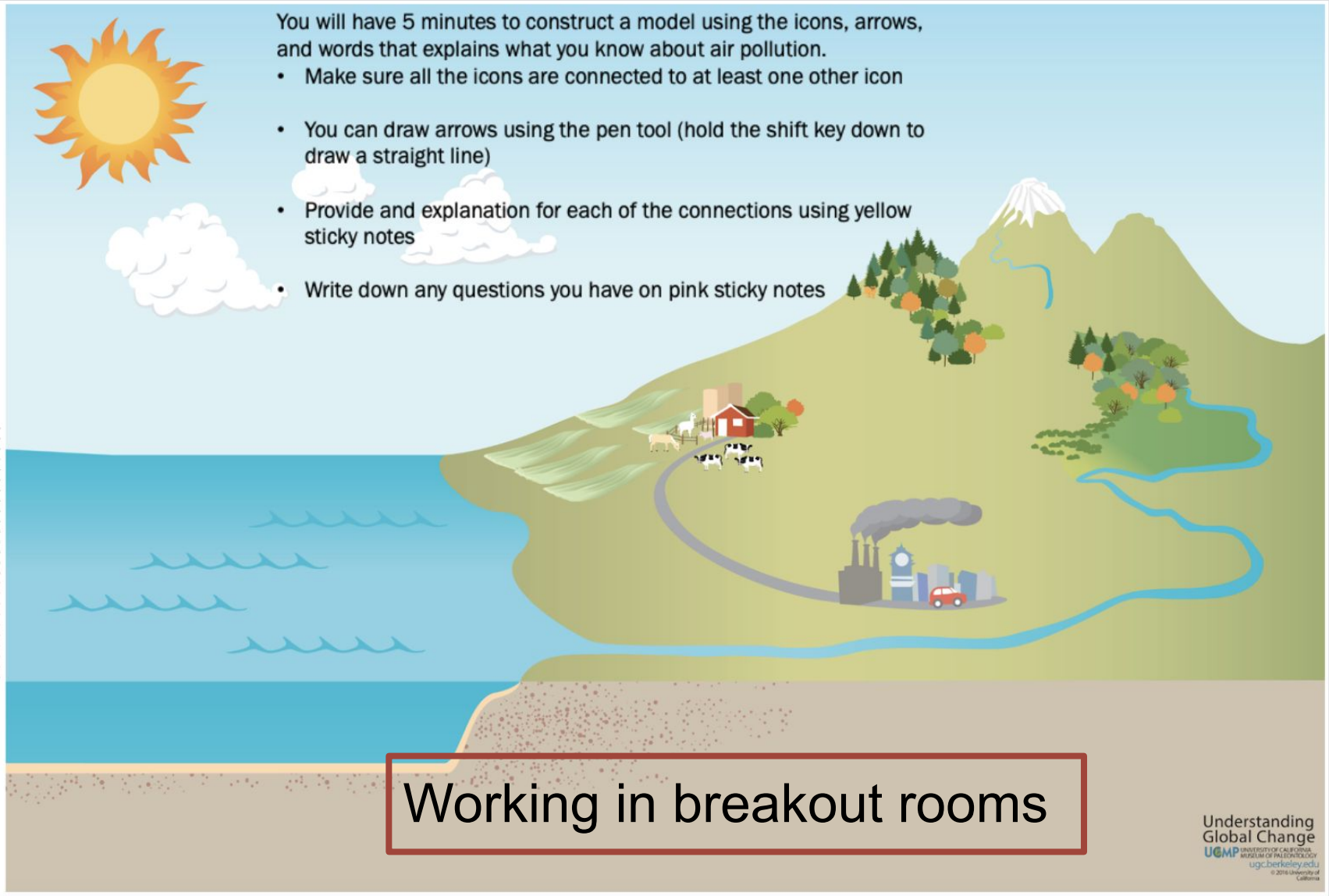

Working in breakout rooms

Understanding Global Change
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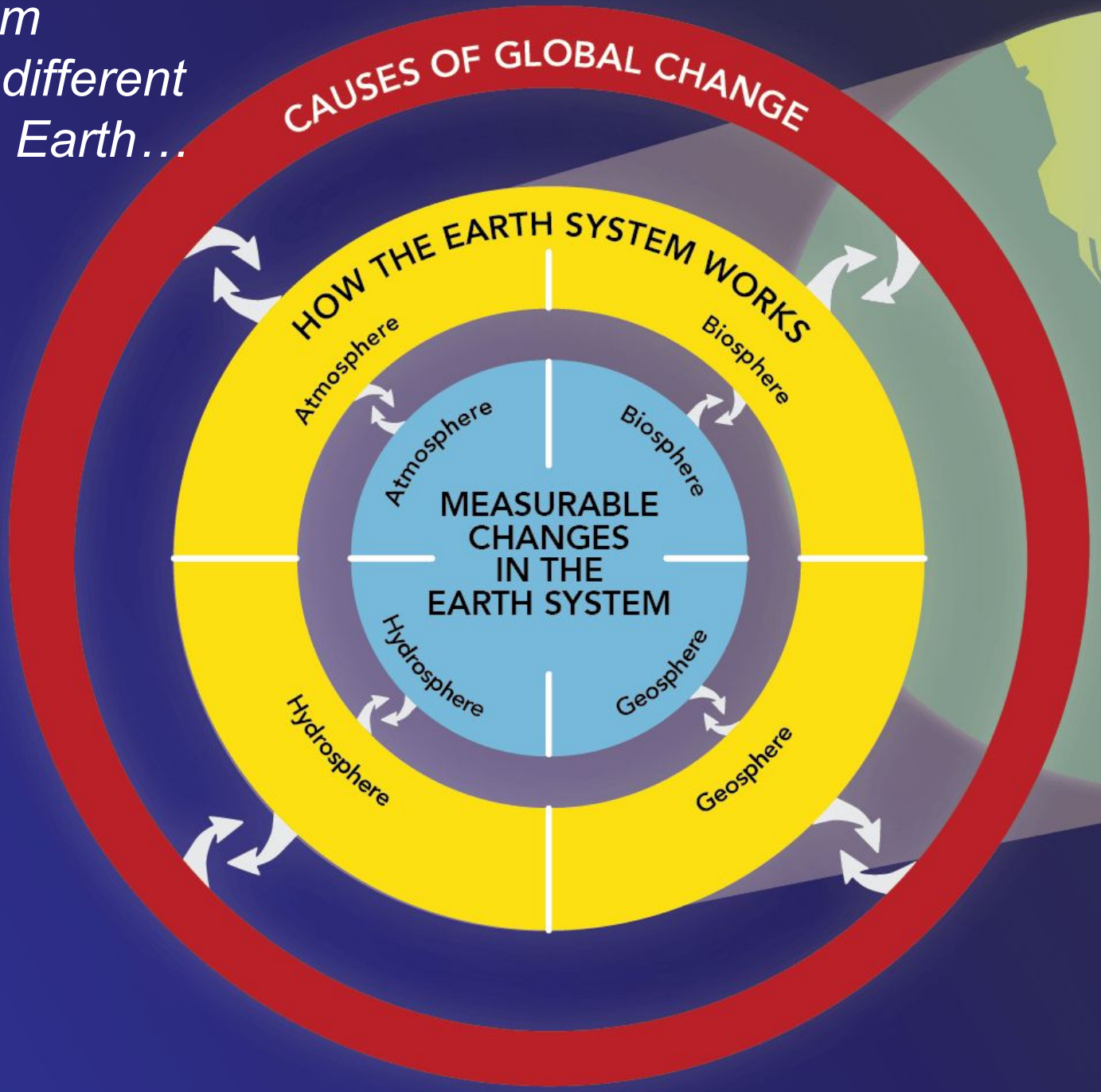
This diagram represents different parts of the Earth…

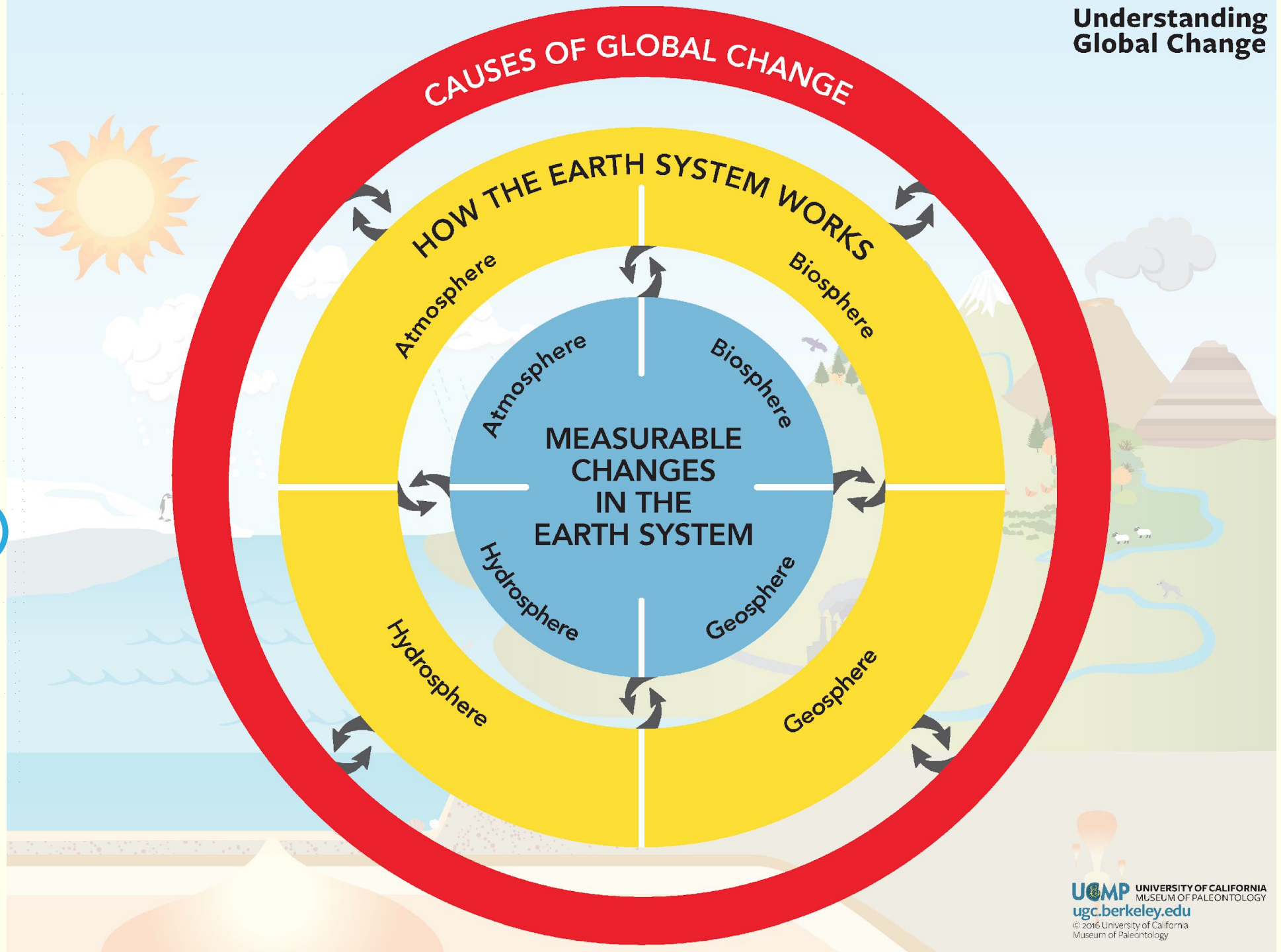


“Understanding Global Change” Framework

This graphic is divided into three primary categories:

- Causes of Change – reasons the Earth changes over time (e.g., human causes, such as pollution, and non-human, such as volcanism)
- Earth System – the big processes that shape the Earth over time, like the water cycle or the greenhouse effect
- Measurable Changes – the observable or measurable changes that occur within the Earth system (e.g., temperature, biodiversity, snow & ice cover)
- The Earth System and Measurable Changes are also divided into the four spheres (atmosphere, hydrosphere, biosphere, and geosphere)

Understanding Global Change



- Burning of fossil fuels
- Urbanization
- Greenhouse effect
- Air quality
- Air temperature
- Airborne particles
- Health

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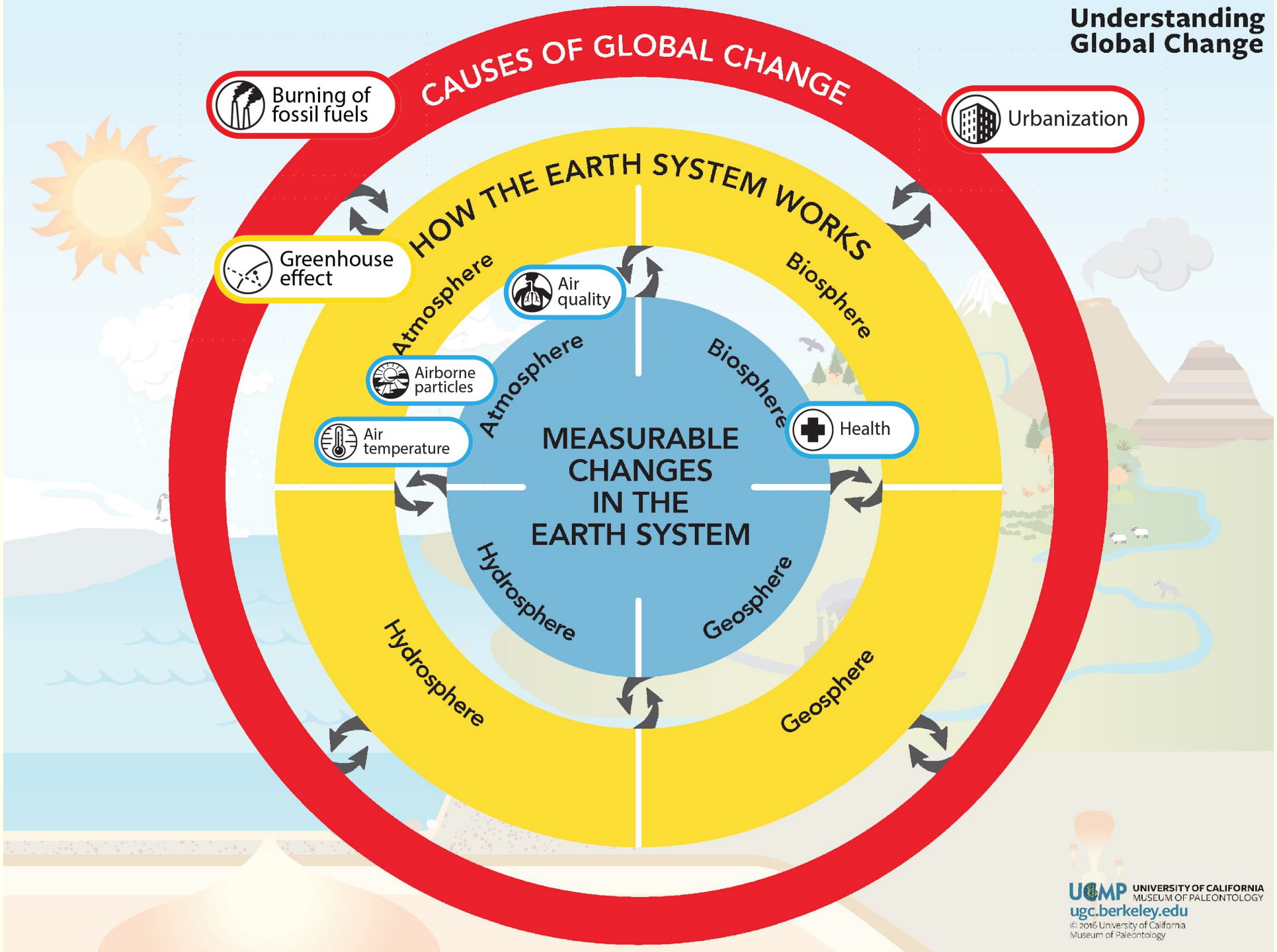
Understanding Global Change



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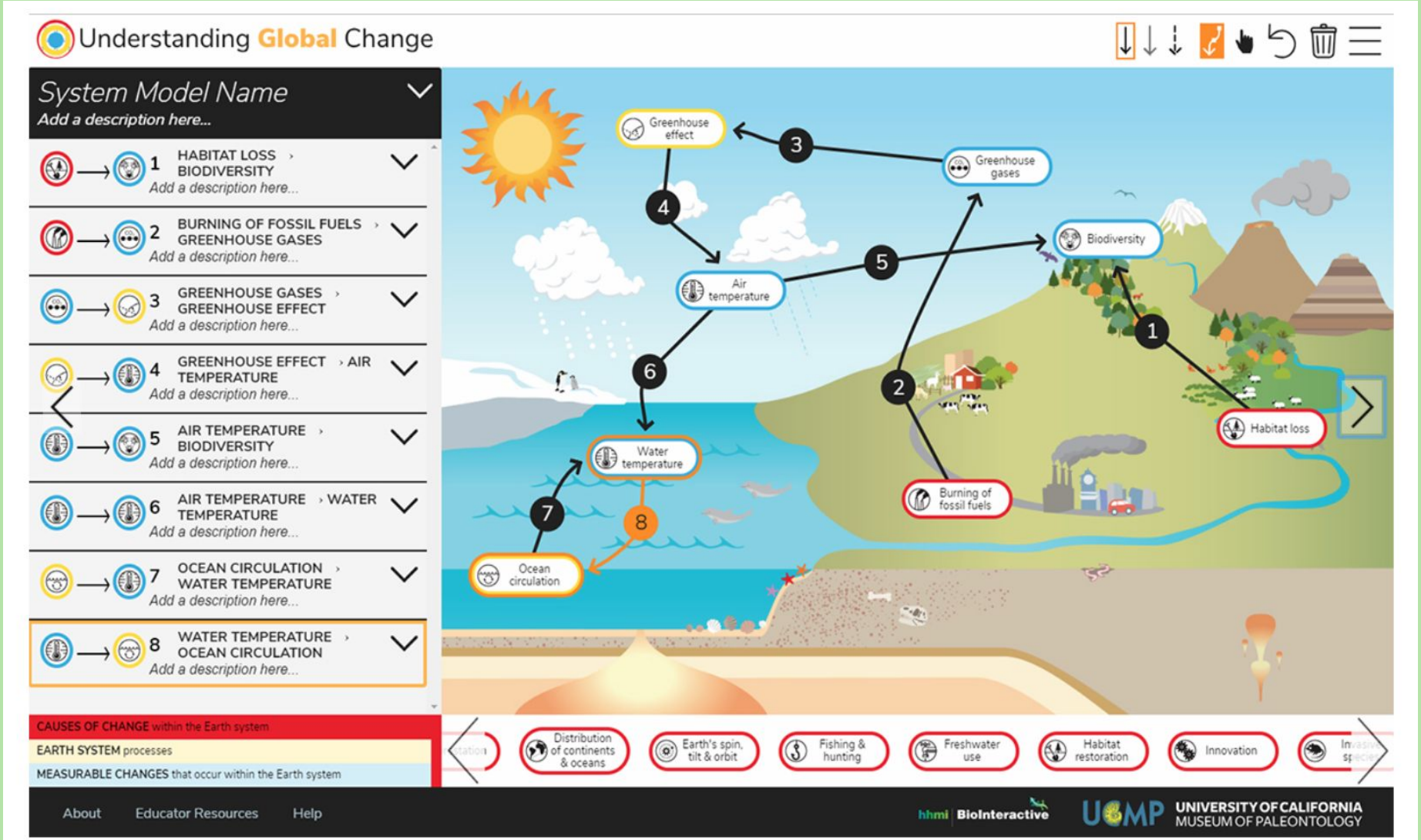
“Understanding Global Change” Interactive



https://tinyurl.com/UGC-Interactive

INVENTING TOMORROW | LESSON PLANS

THE FUTURE IS BRIGHTER THAN YOU THINK

WATER MODULE

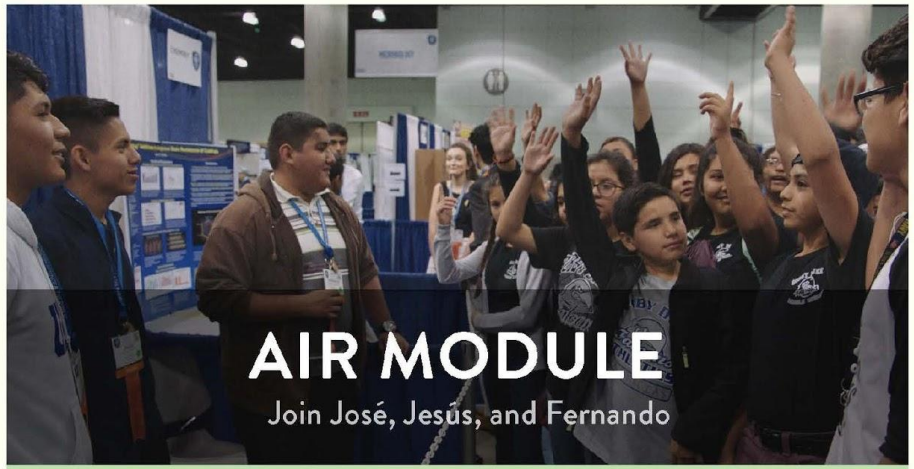
Explore Sahithi's Investigation

LESSONS

1. Sahithi's Story, and the Process of Science
2. What's Happening to Our Water?
3. Modeling Eutrophication with Understanding Global Change
4. Citizen Science: Water Data from Our Community
5. Connecting Water & Air: Sources of Pollution

DOWNLOAD ALL

SEE OVERVIEW >



AIR MODULE

Join José, Jesús, and Fernando

LESSONS

1. José, Jesús, and Fernando's Story, and the Process of Science
2. What's Happening to Our Air?
3. Modeling Air Pollution with Understanding Global Change
4. Citizen Science: Air Quality Data from Our Community
5. Connecting Air & Water: Pollution in Our Waterways

DOWNLOAD ALL

SEE OVERVIEW >

Reflection

Name one thing that you liked or learned today.

Please type responses in the chat!