Smithsonian | STC
Science and Technology Concepts™
Middle School

Setting the Standard for 3D Learning and 3D Assessment

Carolina
K–8 Curriculum

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Learning Framework

Units for Grades 6–8

Physical Science	Life Science	Earth/Space Science
Energy, Forces, and Motion PS2-1, PS2-2, PS2-3, PS2-5, PS3-1, PS3-2, PS3-5, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Ecosystems and Their Interactions** LS1-5, LS1-6, LS2-1, LS2-2, LS2-3, LS2-4, LS2-5, LS4-4, LS4-6, ESS3-3, ETS1-1, ETS1-2	**Weather and Climate Systems** ESS2-4, ESS2-5, ESS2-6, ESS3-2, ESS3-4, ESS3-5, PS3-4, ETS1-1, ETS1-2
Matter and Its Interactions PS1-1, PS1-2, PS1-3, PS1-4, PS1-5, PS1-6, PS3-4, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Structure and Function** LS1-1, LS1-2, LS1-3, LS1-6, LS1-7, LS1-8, LS4-2, LS4-3	**Earth's Dynamic Systems** LS4-1, ESS1-4, ESS2-1, ESS2-2, ESS2-3, ESS3-1,ESS3-2, ETS1-1, ETS1-2, ETS1-3, ETS1-4
Electricity, Waves, and Information Transfer LS1-8, PS2-3, PS2-5, PS3-3, PS3-4, PS3-5, PS4-1, PS4-2, PS4-3, ETS1-1, ETS1-2, ETS1-3, ETS1-4	**Genes and Molecular Machines** LS1-1, LS1-4, LS3-1, LS3-2,LS4-4, LS4-5, LS4-6	**Space Systems Exploration** PS2-4, ESS1-1, ESS1-2, ESS1-3, ETS1-1, ETS1-2

9 Modules grades 6–8

Physical | Earth | Life

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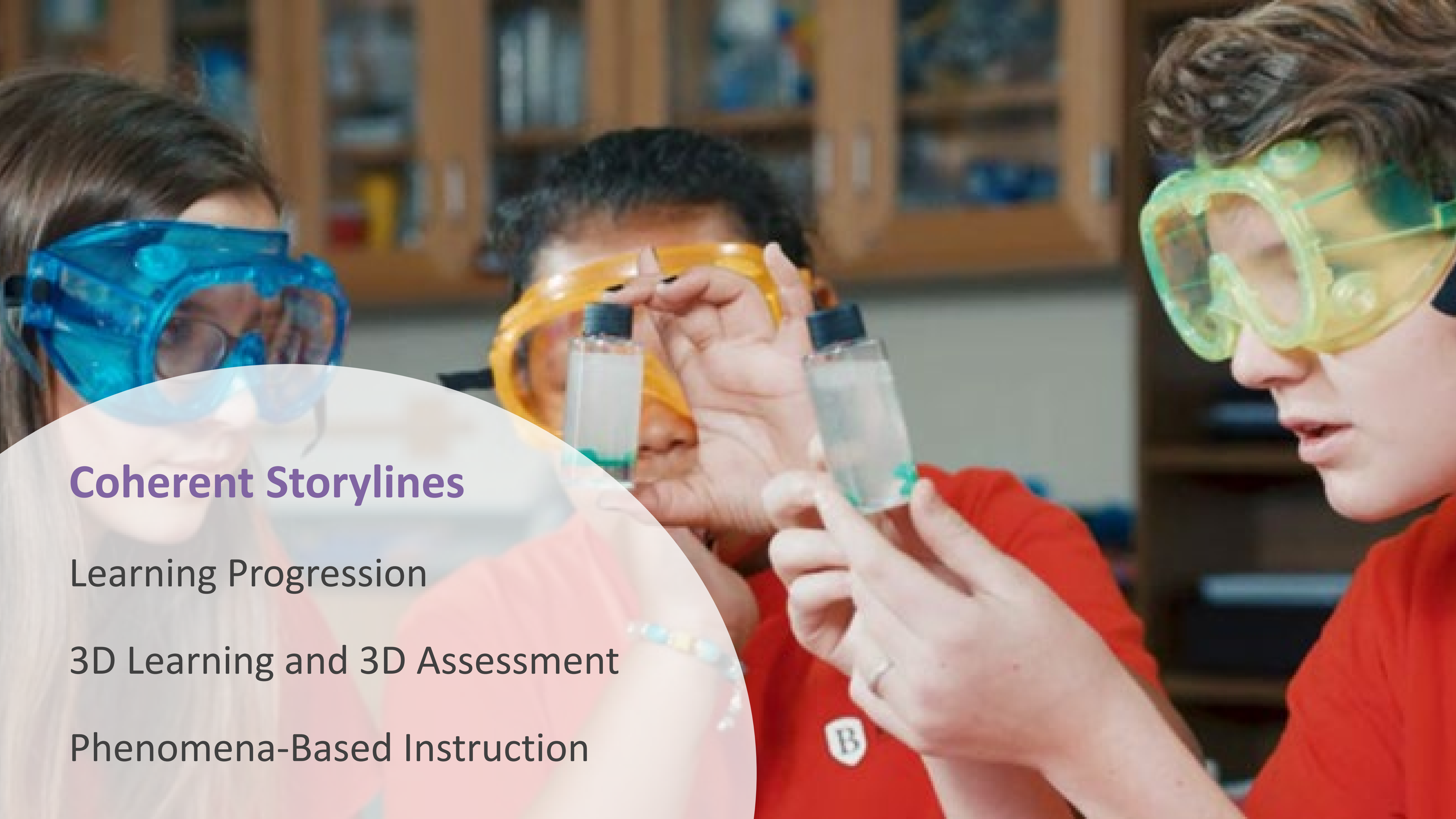
SCIENCE AND TECHNOLOGY CONCEPTS™
MIDDLE SCHOOL

Setting the Standard

Coherent Storylines

Proven Results

Teacher Support



Coherent Storylines

Learning Progression

3D Learning and 3D Assessment

Phenomena-Based Instruction

Matter & Its Interactions

Unit Driving Question: How does matter and its interactions affect everyday life?

Lesson 1: *Pre-Assessment: Matter and Its Interactions*
Focus Question: What do you know about matter?

Lesson 2: *The Nature of Matter*
Focus Question: What can properties of matter help you determine?

Lesson 3: *Density Makes a Difference*
Focus Question: How can density be used to identify a substance and predict how it will behave under different conditions?

Lesson 4: *Just a Phase*
Focus Question: How is energy related to physical changes in matter?

Lesson 5: *Building Blocks of Matter*
Focus Question: How can you use a model to describe the composition of matter?

Lesson 6: *Pure Substances and Mixtures*
Focus Question: How can mixtures be separated?

Lesson 7: *Reacting Chemically*
Focus Question: How can the properties of matter be used to determine if a chemical reaction has occurred?

Lesson 8: *Releasing Energy*
Focus Question: What is the relationship between changes in substances and changes in thermal energy?

Lesson 9: *Conservation of Matter*
Focus Question: What happens to matter in a chemical reaction?

Lesson 10: *Compounds from Natural Resources*
Focus Question: How are synthetic compounds made and used?

Lesson 11: *Assessment: Matter and Its Interactions*
Focus Question: How can we use our knowledge of matter and its interactions to solve problems?

Coherent Storylines

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Getting Started

1. In the previous lesson, you learned that substances have physical and chemical properties that can be used to identify them. In this lesson, you focus on one physical property: density. You will work in groups to learn how to calculate the density of an object or substance. Also, you will model the organization of particles in substances with different densities and use your model to predict how these substances interact. Remember to follow your teacher's instructions carefully throughout the lesson. Be sure to complete your work neatly and accurately.
2. In your science notebook, write some examples of physical properties from previous lessons. What makes these properties physical properties? Write your responses in your science notebook. Be prepared to contribute your ideas to a class discussion.
3. Read Building Your Knowledge: *Density as a Physical Property*. In your own words, summarize the relationships among mass, volume, and density in your science notebook. Your teacher will lead a class discussion of these relationships.
4. **Models** are tools that scientists use to represent ideas, processes and systems. The diagrams you drew in Lesson 2 are a type of model. Draw a diagram to model the two spoons described in *Density as a Physical Property*. Remember that the spoons are the same size, but one spoon has more mass and higher density. Use simple shapes, such as circles, to represent the particles in your model.
5. Share your density drawing with the class. As a class, discuss the meanings of matter, mass, volume, and density.
6. Look at the object in Figure 3.1. How can density be used to identify what substance this object is made of? Record your response in your science notebook.
7. For some investigations in this lesson, you will use an electronic balance assigned by your teacher. Your group will share the balance with other groups. Before you place anything on the balance, make sure that it reads 0.0 grams (g). If the balance does not read 0.0 g, press the button labeled ZERO. Wait for 0.0 g to appear before continuing. After you have placed an object on the balance, wait a few seconds for the reading to stabilize before recording your measurement.

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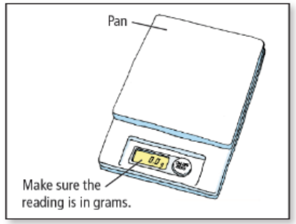


Figure 3.2
Make sure the balance reads 0.0 g before placing an object on it.

Getting Started *continued*

8. During this lesson, you will use graduated cylinders and graduated cups to measure volume. Your teacher will provide your group with these materials so you can look at them. Together with your group, discuss the following questions and be prepared to share your ideas with the class:
   a. Both of these scientific tools are described using the term graduated. What do you think graduated means?
   b. These tools are similar to something you may use to measure at home. What items in your home do these remind you of? What are those items used to measure?
   c. What are the units of measure on the plastic cup? What is the maximum amount it can measure? What is the minimum?
   d. What is the unit of measure for the graduated cylinder? What is the maximum amount it can measure? What is the minimum amount it can measure?
   e. Look at the smallest division on the graduated cylinder. What amount does the smallest division measure?
   f. When would you want to use a disposable measuring device (like a graduated cup) instead of a reusable one (like a graduated cylinder)?
9. Watch the demonstration for the proper procedure for measuring volume using a graduated cylinder. Ask questions about anything that is unclear to you.

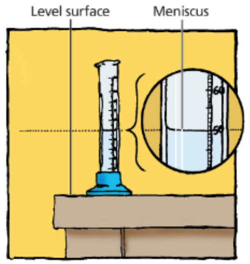


Figure 3.3
Make sure the graduated cylinder is on a level surface. When you take a reading, make sure your eye is level with the bottom of the meniscus. The meniscus is the curved upper surface of the liquid in the cylinder.

BUILDING YOUR KNOWLEDGE — READING SELECTION

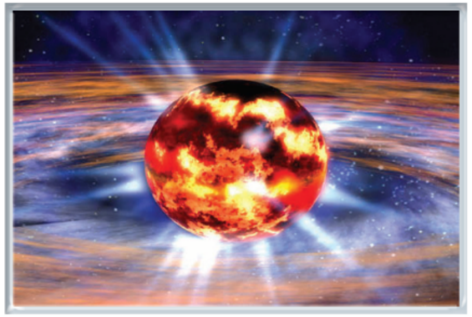
Density as a Physical Property

You've compared the density of objects before, even if you didn't know the meaning of density. Imagine holding two spoons of the same size and shape. One spoon is made of plastic and one spoon is made of metal. The spoons take up the same amount of space, but the metal spoon feels much heavier than the plastic spoon. How is this possible? Even though both spoons are the same size and occupy the same amount of space, the atoms in the metal spoon are more massive and packed more closely together. As more mass is crammed into a given space, the object gets denser.

We can't tell how objects differ in density just by looking at them, but we can tell how they differ by measuring the mass and volume of the objects. A clay brick might be denser than a same-sized brick made of solid foam. But you wouldn't know for sure unless you measured the mass and volume of each brick to calculate its density. So, how do you find an object's density?

Scientists often measure mass in grams (g) and volume in cubic centimeters (cm^3). These units are also used to describe the density. Density is a measure of how much mass is crammed into a certain volume of space. It is measured in grams per cubic centimeter (or other unit of mass per unit of volume). ■

Did you know there's empty space between the atoms of your spoon? Well, there is. You'd be surprised just how much mass can be squeezed together, too. Take neutron stars—the nearly dead, nearly burnt-out remnants of stars much larger than our Sun. A neutron star, according to Dr. Dave Goldberg, co-author of *A User's Guide to the Universe*, can have two or three times our Sun's mass, all of it packed into a ball that could fit inside the borders of Philadelphia. That's pretty dense!



After a star explodes as a supernova, it collapses and the particles are packed together to form a neutron star. A neutron star is so dense that a piece the size of a sugar cube would weigh more than 1 billion metric tons (1.1 billion U.S. tons).

CREDIT: NASA/Dana Berry

Coherent Storylines

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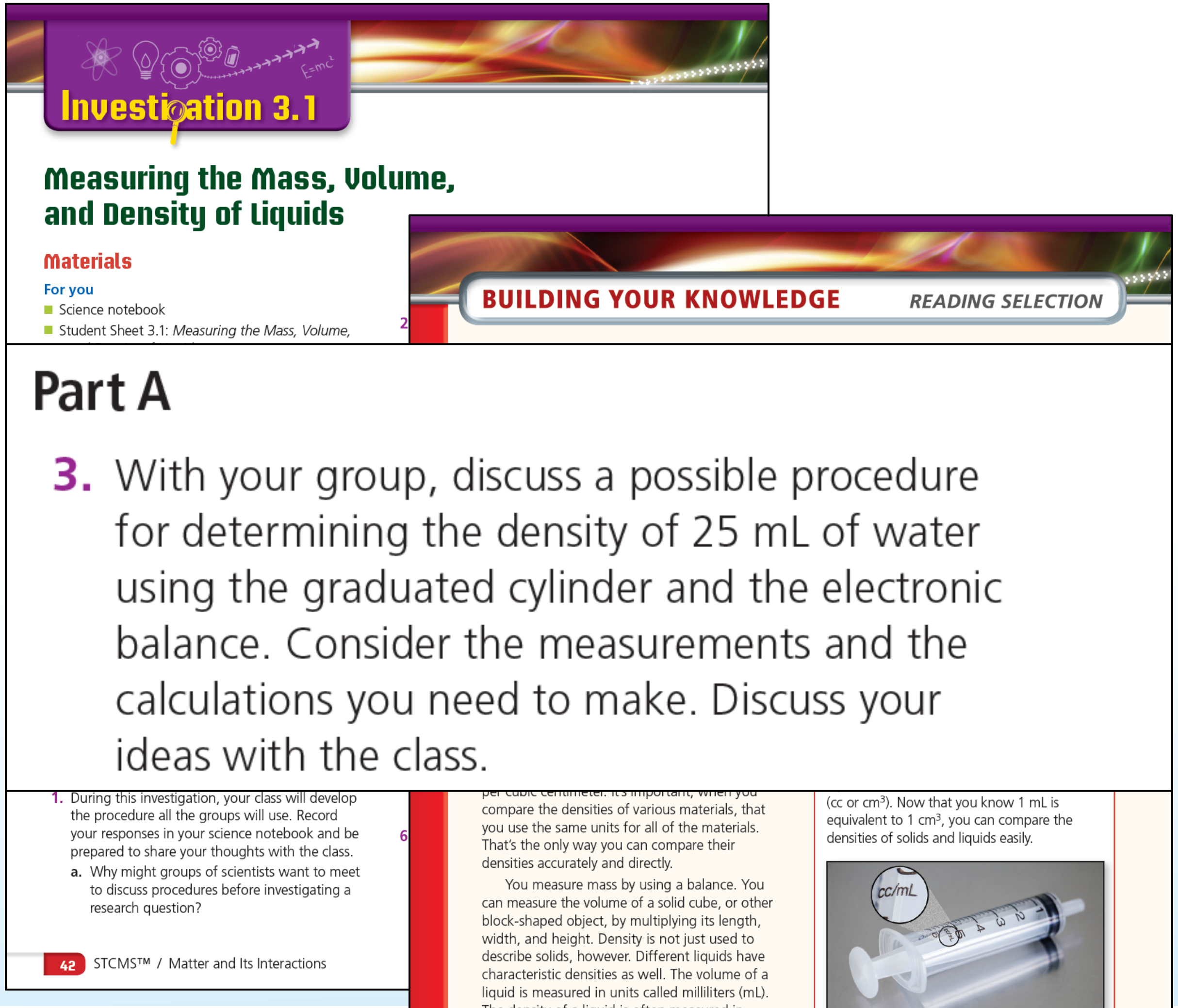

Investigation 3.1

Measuring the Mass, Volume, and Density of Liquids

Materials

For you

- Science notebook
- Student Sheet 3.1: *Measuring the Mass, Volume,*

BUILDING YOUR KNOWLEDGE *READING SELECTION*

Part A

3. With your group, discuss a possible procedure for determining the density of 25 mL of water using the graduated cylinder and the electronic balance. Consider the measurements and the calculations you need to make. Discuss your ideas with the class.

1. During this investigation, your class will develop the procedure all the groups will use. Record your responses in your science notebook and be prepared to share your thoughts with the class.
   a. Why might groups of scientists want to meet to discuss procedures before investigating a research question?

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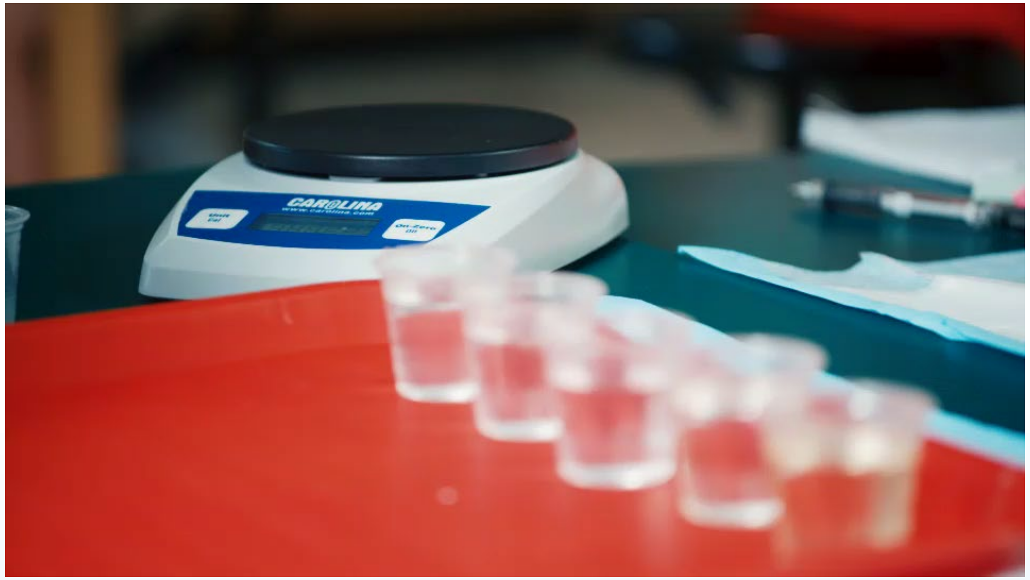
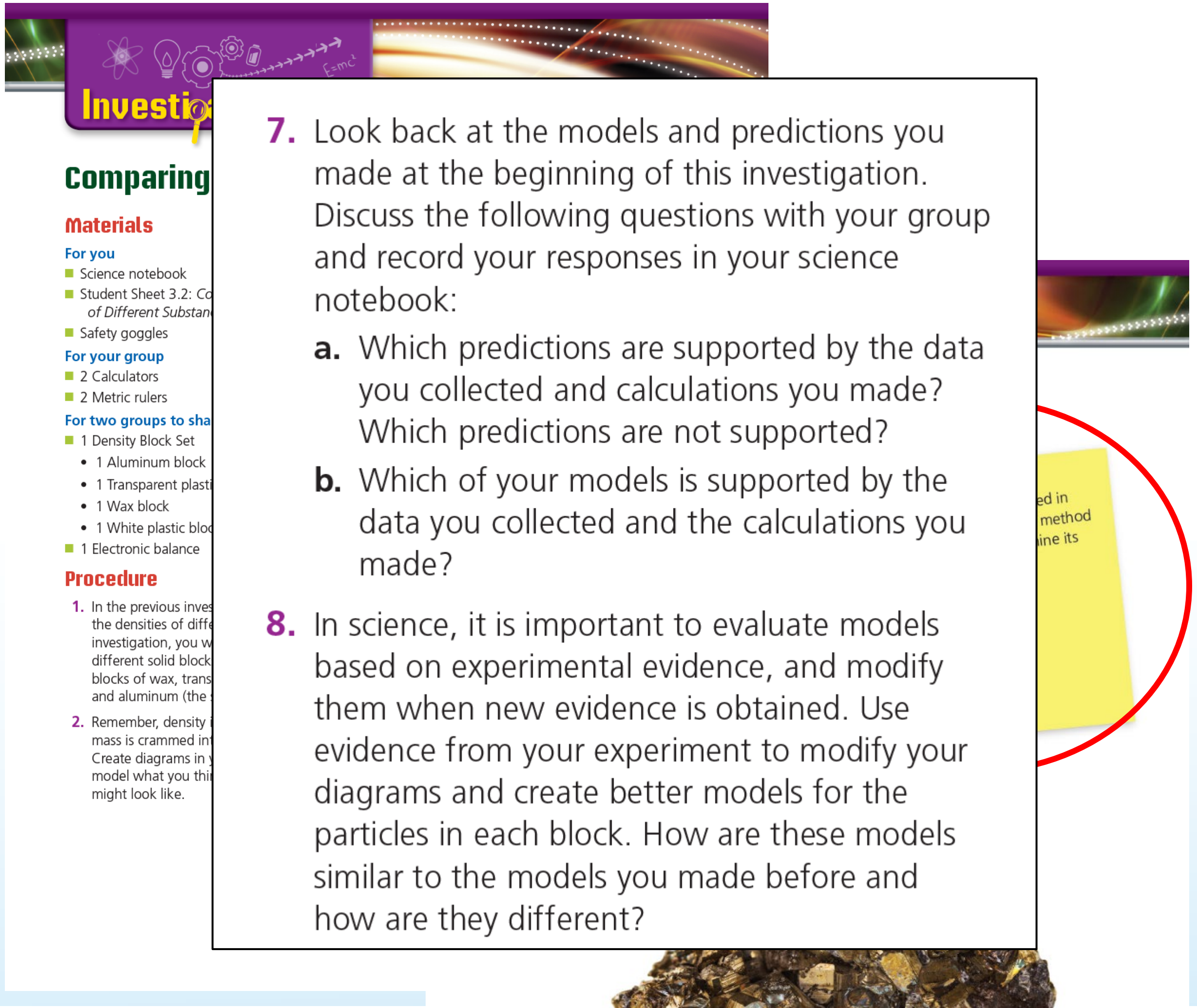
compare the densities of various materials, that you use the same units for all of the materials. That's the only way you can compare their densities accurately and directly.

You measure mass by using a balance. You can measure the volume of a solid cube, or other block-shaped object, by multiplying its length, width, and height. Density is not just used to describe solids, however. Different liquids have characteristic densities as well. The volume of a liquid is measured in units called milliliters (mL).

(cc or cm^3). Now that you know 1 mL is equivalent to 1 cm^3, you can compare the densities of solids and liquids easily.



Coherent Storylines



7. Look back at the models and predictions you made at the beginning of this investigation. Discuss the following questions with your group and record your responses in your science notebook:
   a. Which predictions are supported by the data you collected and calculations you made? Which predictions are not supported?
   b. Which of your models is supported by the data you collected and the calculations you made?
8. In science, it is important to evaluate models based on experimental evidence, and modify them when new evidence is obtained. Use evidence from your experiment to modify your diagrams and create better models for the particles in each block. How are these models similar to the models you made before and how are they different?

Coherent Storylines

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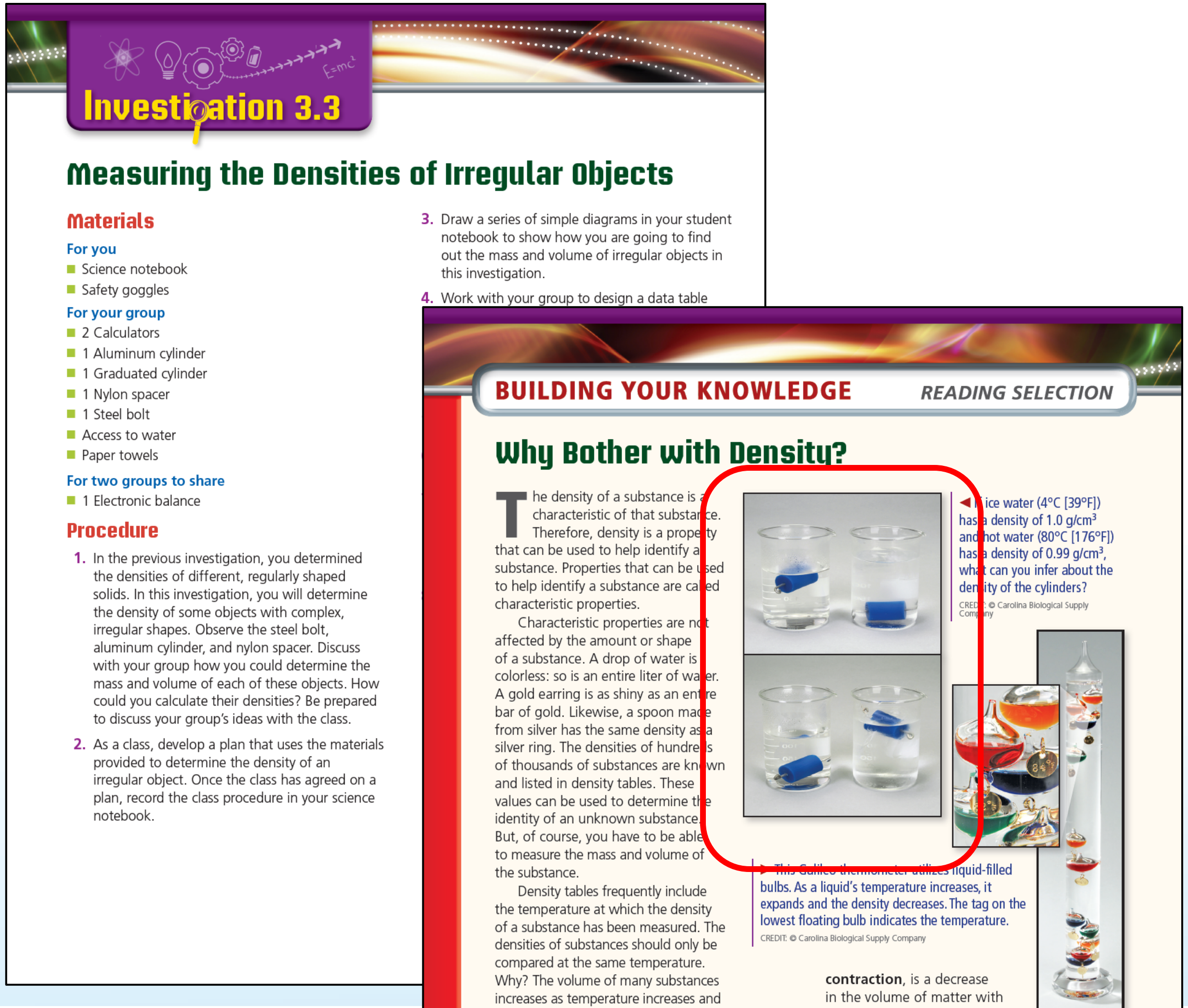

Investigation 3.3

Measuring the Densities of Irregular Objects

Materials

For you
- Science notebook
- Safety goggles

For your group
- 2 Calculators
- 1 Aluminum cylinder
- 1 Graduated cylinder
- 1 Nylon spacer
- 1 Steel bolt
- Access to water
- Paper towels

For two groups to share
- 1 Electronic balance

Procedure

1. In the previous investigation, you determined the densities of different, regularly shaped solids. In this investigation, you will determine the density of some objects with complex, irregular shapes. Observe the steel bolt, aluminum cylinder, and nylon spacer. Discuss with your group how you could determine the mass and volume of each of these objects. How could you calculate their densities? Be prepared to discuss your group's ideas with the class.
2. As a class, develop a plan that uses the materials provided to determine the density of an irregular object. Once the class has agreed on a plan, record the class procedure in your science notebook.
3. Draw a series of simple diagrams in your student notebook to show how you are going to find out the mass and volume of irregular objects in this investigation.
4. Work with your group to design a data table

BUILDING YOUR KNOWLEDGE — READING SELECTION

Why Bother with Density?

The density of a substance is a characteristic of that substance. Therefore, density is a property that can be used to help identify a substance. Properties that can be used to help identify a substance are called characteristic properties.

Characteristic properties are not affected by the amount or shape of a substance. A drop of water is colorless: so is an entire liter of water. A gold earring is as shiny as an entire bar of gold. Likewise, a spoon made from silver has the same density as a silver ring. The densities of hundreds of thousands of substances are known and listed in density tables. These values can be used to determine the identity of an unknown substance. But, of course, you have to be able to measure the mass and volume of the substance.

Density tables frequently include the temperature at which the density of a substance has been measured. The densities of substances should only be compared at the same temperature. Why? The volume of many substances increases as temperature increases and

◀ If ice water (4°C [39°F]) has a density of 1.0 g/cm³ and hot water (80°C [176°F]) has a density of 0.99 g/cm³, what can you infer about the density of the cylinders?

CREDIT: © Carolina Biological Supply Company

▶ This Galileo thermometer utilizes liquid-filled bulbs. As a liquid's temperature increases, it expands and the density decreases. The tag on the lowest floating bulb indicates the temperature.

CREDIT: © Carolina Biological Supply Company

contraction, is a decrease in the volume of matter with

Coherent Storylines

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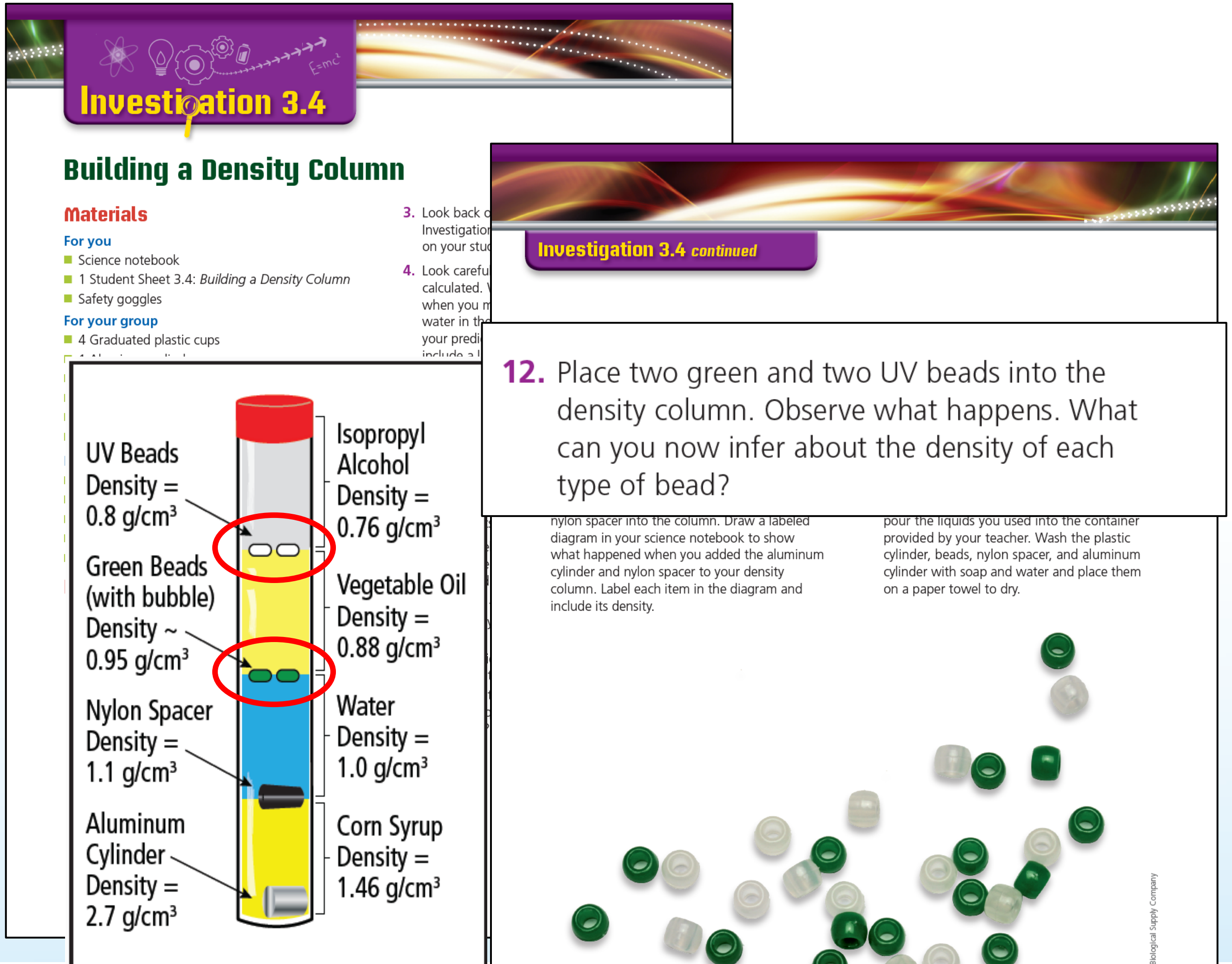
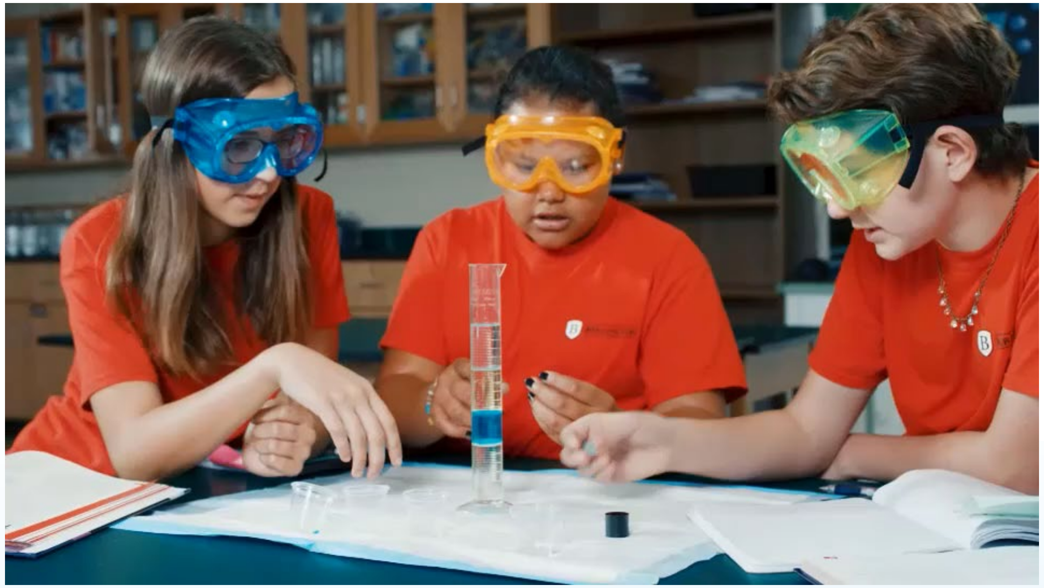




Coherent Storylines

Investigation 3.5

Building a Density Bottle

Materials

For your teacher

- Bottle containing beads

For you

- Science notebook
- 1 Student Sheet 3.5: *Building a Density Bottle*
- Safety goggles

For your group

- 6 Graduated plastic cups
- 1 Jar of beads
- 1 Plastic bottle
- Access to water
- Paper towels

For two groups to share

- 1 Electronic balance

For the class

- Containers for used liquids
- Corn syrup
- Isopropyl alcohol
- Salt brine
- Vegetable oil
- Vinegar
- Access to water

Procedure

1. In the previous investigation, you made predictions about the appearance of different substances when they are combined. In this investigation, you apply what you have learned about density to design a density bottle similar to the one you used in the pre-assessment activity. (See Figure 3.5.) Look back at your observations from Investigation 1.6: Beads in a Bottle. How has your understanding of the substances in this bottle changed since then? Discuss your answer with the class.
2. Look back on the data you collected in Investigation 1.6: Beads in a Bottle. What does the data you collected tell you about the density of each type of bead?
3. Look back on the data you collected during Investigation 3.1, and use it to fill in Table 1 on Student Sheet 3.5: *Building a Density Bottle*. Your teacher used two of the liquids from Investigation 3.1 to create the bottle you used in the pre-assessment. Do you have enough information to determine what liquids your teacher used? Why or why not?
4. Use the graduated cups to obtain 30-mL samples of each liquid you think your teacher may have used. Place one green and one UV bead in each cup and record your observations in Table 1. (Check to ensure that no beads have air bubbles attached to them.)

continued

Figure 3.5
What liquids do you think your teacher used to create this bottle?

3-Dimensional Assessment

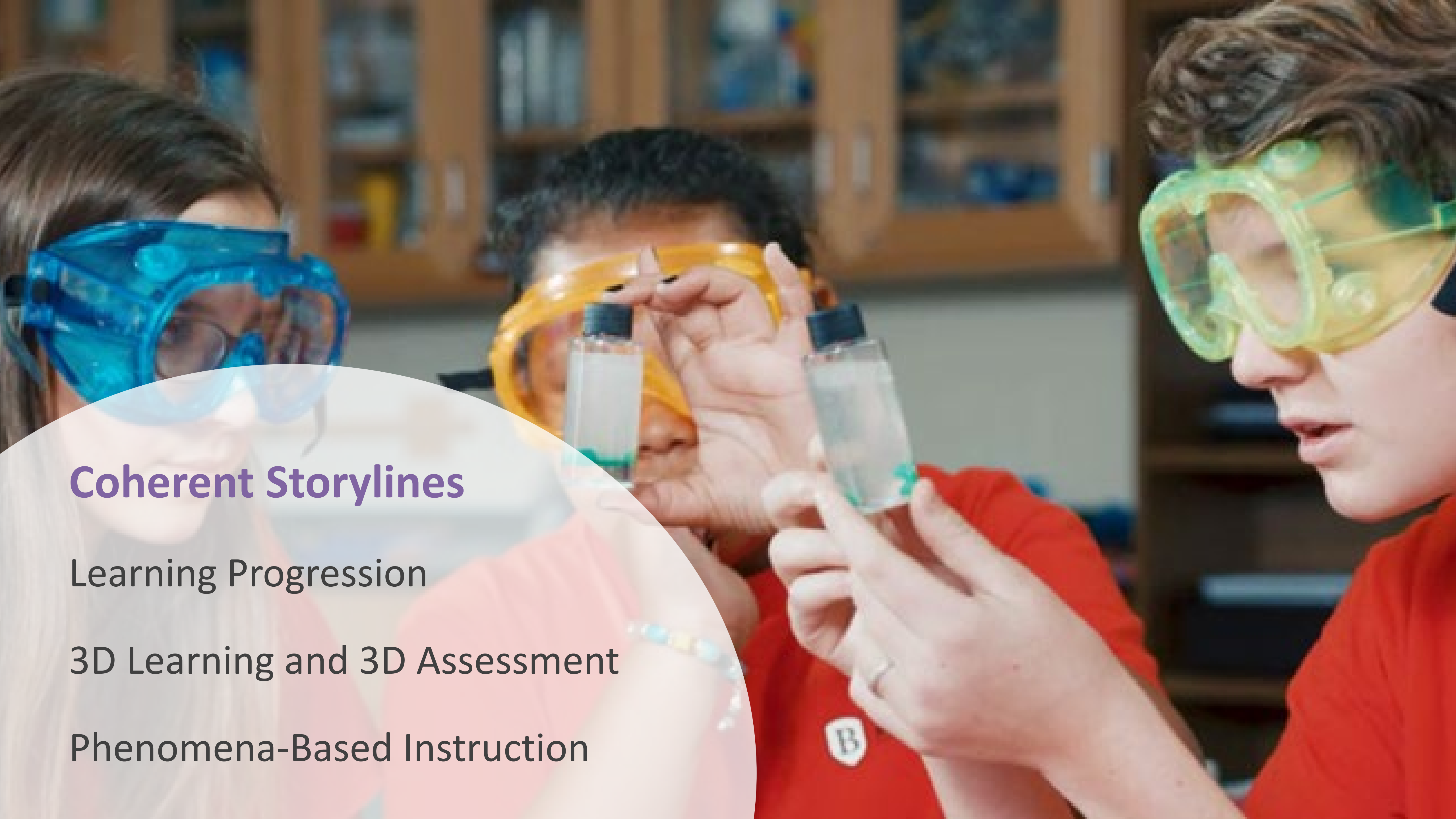
Lesson Master 8.2a: Design Challenge Scoring Rubric

Hot Pack Design				
Criterion	**1. Beginning**	**2. Developing**	**3. Proficient**	**4. Exemplary**
Design for the Outer Bag	Group designed an outer bag without a warning label.	Group designed an outer bag with a warning label, but it does not describe relevant concerns.	Group designed an outer bag with a warning label that accurately includes a potential hazard, ecological concern, or storage instruction.	Group designed an outer bag with a warning label that accurately includes potential hazards, ecological concerns, and storage instructions.
Temperature Reduction	Group designed a hot pack with contents that reached a temperature between 20°C and 30°C or over 55°C.	Group designed a hot pack with contents that reached a temperature between 30°C and 40°C.	Group designed a hot pack with contents that reached a temperature between 40°C and 50°C.	Group designed a hot pack with contents that reached a temperature between 50°C and 55°C.
Cost	Group designed a hot pack with an amount of solid chemical that costs less than $1.00.	Group designed a hot pack with an amount of solid chemical that costs less than $0.70.	Group designed a hot pack with an amount of solid chemical that costs less than $0.50.	Group designed a hot pack with an amount of solid chemical that costs less than $0.25.

Grading Rubric				
Criterion	**1. Beginning**	**2. Developing**	**3. Proficient**	**4. Exemplary**
Written Instructions and Schematics	Group did not present written instructions or schematics pertaining to the design challenge.	Group presented either written instructions or schematics that were unclear or incomplete but pertained to the design challenge.	Group presented either written instructions or schematics that were clear and pertained to the design challenge.	Group presented written instructions and schematics that were clear, detailed, and pertained to the design challenge.
Design Implementation	Group constructed a design that did not pertain to the design challenge.	Group constructed a design that somewhat pertained to the design challenge.	Group constructed a design that met the criteria of the design challenge.	Group constructed a design that exceeded the criteria of the design challenge.
Testing and Data Collection	Group did not test their design.	Group did not use appropriate procedures to test their design and did not collect relevant data.	Group used appropriate procedures to test their design but did not collect relevant data.	Group used appropriate procedures to test their design and collected relevant data.
Reflection and Presentation	Group presented methods and results in an incomplete and unclear manner and did not reflect on choices.	Group presented methods or results in an unclear manner or did not reflect on choices based on scientific principles.	Group presented methods or results adequately. Group reflected on choices based on scientific principles most of the time.	Group presented methods or results clearly and accurately. Group always reflected on choices based on scientific principles.

Three-dimensional assessment is built into each unit, lesson, and investigation.

- Pre-Assessment
- Formative Assessment
- Summative Assessment
- Rubrics



Coherent Storylines

Learning Progression

3D Learning and 3D Assessment

Phenomena-Based Instruction

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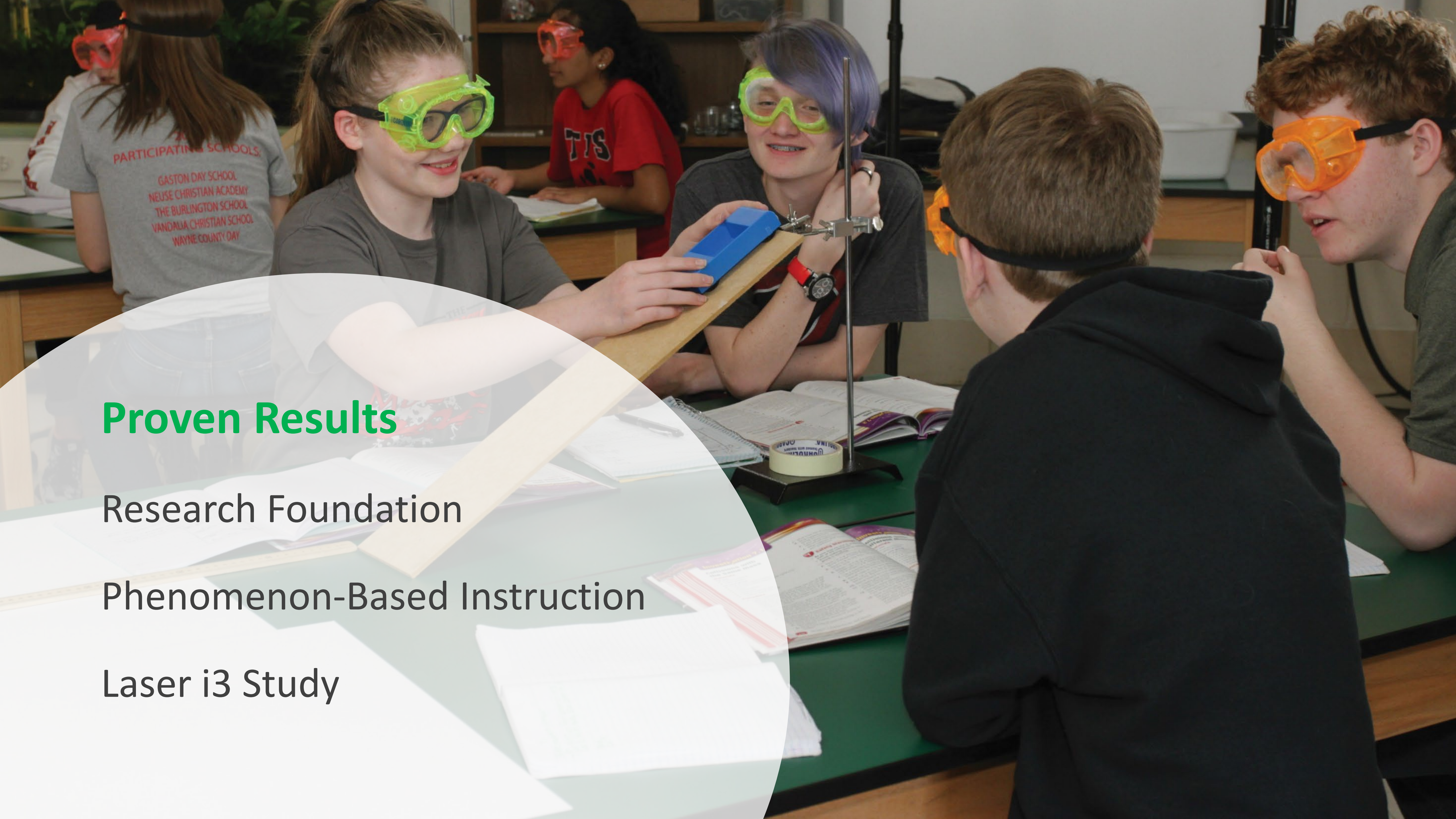
Setting the Standard

Coherent Storylines

Proven Results

Teacher Support



Proven Results

Research Foundation

Phenomenon-Based Instruction

Laser i3 Study

Proven Results

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NASA

United States Environmental Protection Agency

eMammal

Smithsonian
Science Education Center

Carolina K-8 Curriculum

USDA
United States Department of Agriculture

NOAA
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

Proven Results

Smithsonian | STC Science and Technology Concepts™ Middle School

Research-Based and Proven

Inquiry-Based Science Raises Scores in Science, Reading, and Math

5 Year

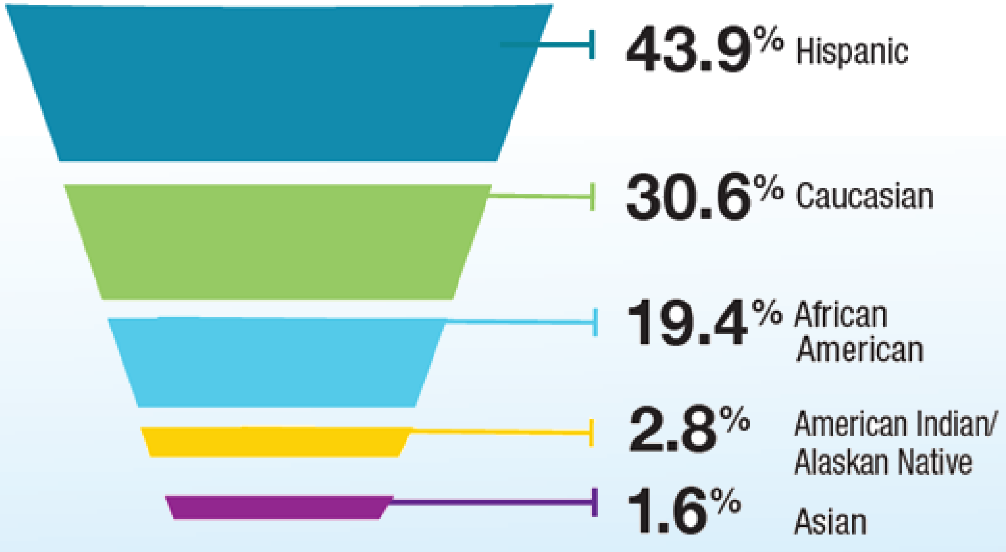
LASER i3 Research Study

The LASER* model of inquiry-based science education resulted in **statistically significant** and **educationally meaningful** improvements in achievement in **science**, **reading**, and **mathematics** as measured by standardized state assessments.

* The Leadership and Assistance for Science Education Reform model developed by the Smithsonian Science Education Center

60,000

Grades 1–8 students impacted



Demographic information represents a subsample of 6,291 students in the study.

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Proven Results

Research-Based and Proven

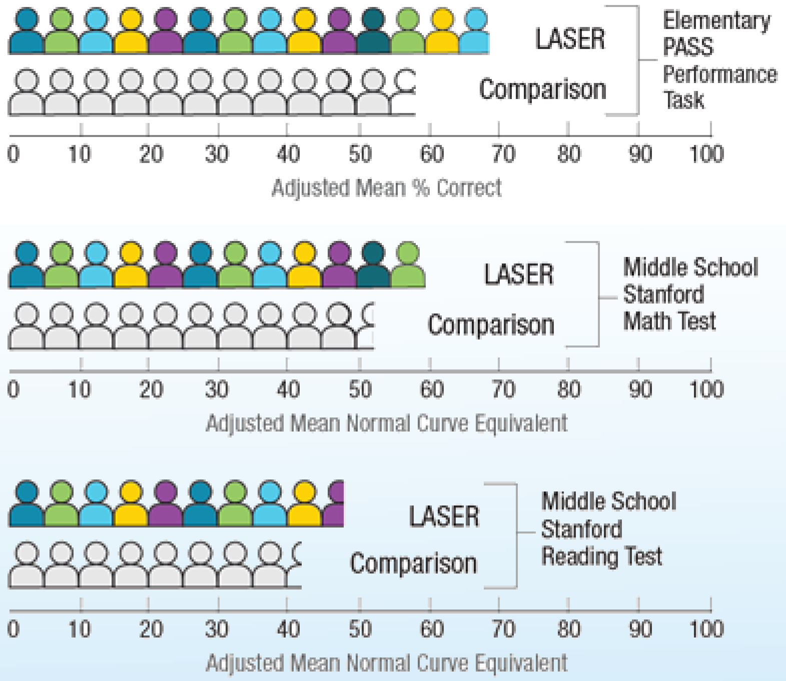
Inquiry-Based Science
Raises Scores in Science, Reading, and Math

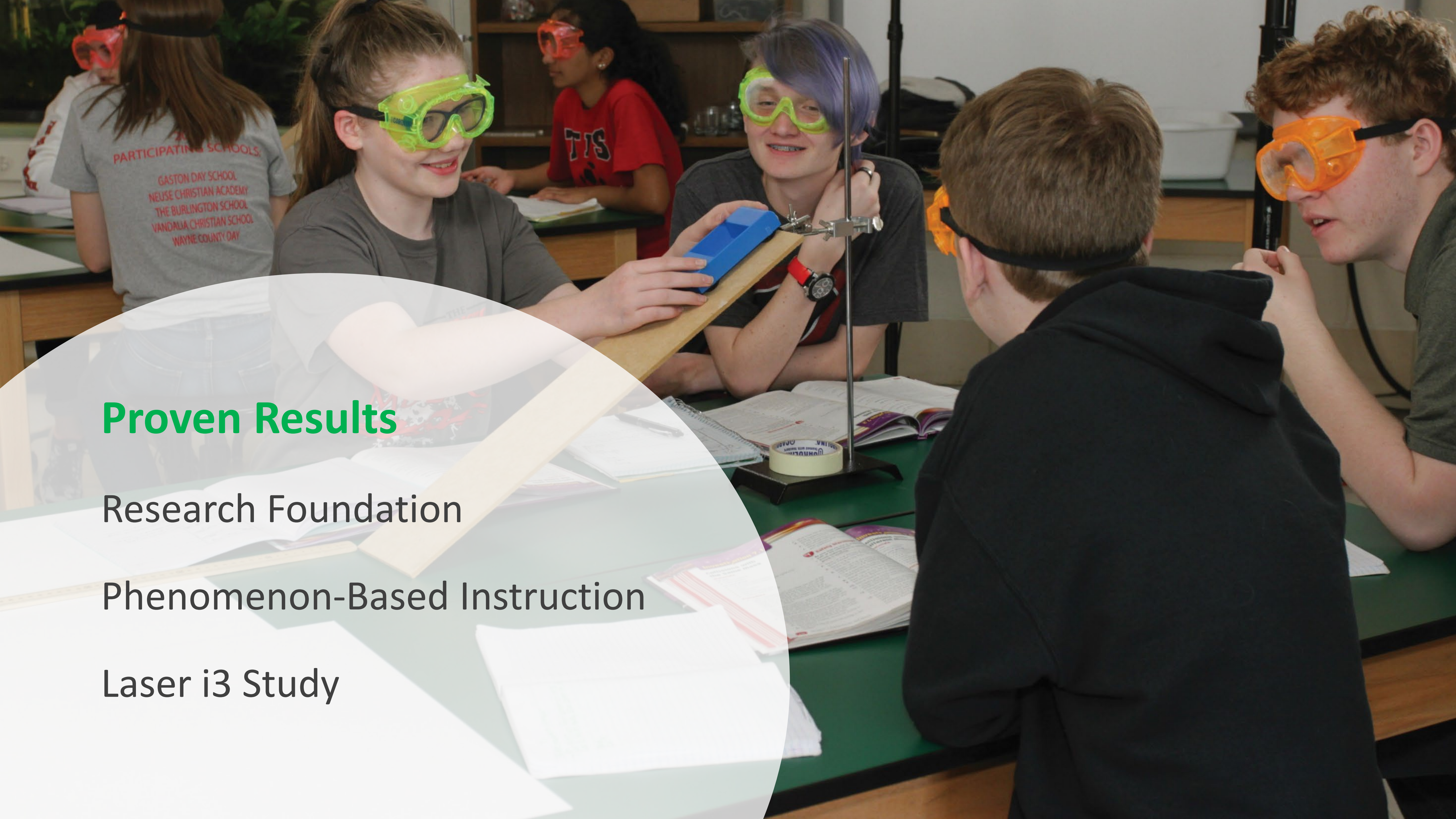
Inquiry Based

A student-centered method where students ask questions, solve problems, and design solutions and the teacher facilitates learning

Gains in science, reading, and math

Elementary and middle school students in the Houston Independent School District outperformed their peers in science, reading, and math.





Proven Results

Research Foundation

Phenomenon-Based Instruction

Laser i3 Study

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Setting the Standard

Coherent Storylines

Proven Results

Teacher Support

Teacher Support

Easy-to-Use Teacher Edition

New Easy-to-Use Digital Resources

Professional Learning

Teacher Support

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Unit Overview

In **Lesson 5**, students explore the conditions under which the ocean gains and loses heat energy and develops two kinds of (ultimately) heat-driven currents: surface currents and deep currents. Students are introduced to the ocean as a reservoir and transporter of heat. They also study ways in which ocean currents move heat around the globe.

The lesson begins as students investigate how Earth's shape and orientation to the Sun result in uneven heating of its surfaces. Then, over the course of three investigations, students explore the effects of water's fluctuating density and the wind on ocean currents. In Investigation 5.1, they determine how temperature affects currents. Then they discover the role that salinity plays in driving the ocean's movements in Investigation 5.2. Finally, students explore surface currents in Investigation 5.3 to see how wind impacts ocean currents.

In **Lesson 6**, students learn what conditions are necessary for the formation of storms, particularly the vortices known as hurricanes and tornadoes. Students begin by studying satellite images and drawing the parts of a hurricane. During Investigation 6.1, students use a model made with two connected bottles filled with water and glitter to simulate and observe a vortex. They apply their observations of the model to th... a tornado or hurricane and dev... the word "vortex." By the end... will demonstrate an understand... form and behave.

In **Lesson 7**, students beg... with weathe... weather pred... Investigation... a five-day pr... collecting da... observing cl... patterns and... the data, and... predict the w... relationships... Some of the... need to be d... Investigation... their observa... maps and dr... the condition... and storms f... Investigation... after student... time to colle... students ana... their weathe... patterns they... students sha... their weathe... the class and... explanations... weather data...

In Lesson... the impacts o... how the storm... Students inve...

CREDIT: NASA Goddard Space Flight Center/NOAA

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In **Lesson 10**, students explore the data scientists collect related to climate change. Students have been exposed to the uncertainty scientists face in collecting and interpreting data, and they are beginning to develop a sense of what it means to make tentative statements of fact based on data that is imperfect and fragmentary but intelligently collected and analyzed.

Students explore these concepts by measuring the temperature in an area and then finding a way to represent the data with a single value. Next, students are presented with and discuss how and why different types of data are collected as evidence of climate change. Each group is assigned or selects a graph of climate data to analyze and interpret. Students engage in research aimed at a deeper, more contextualized understanding of what the graph means, how its data has been collected, and why the subject under study is important. Then, in Investigation 10.2, students present their research to the class, allowing the whole class to get familiar with different pieces of climate change research.

In **Lesson 11**, students analyze the impact of climate change, explore how scientists project trends to predict the future, and explore how scientists simulate future conditions and monitor effects. Students recall what they have learned in previous lessons about climate change and consider how scientists make climate predictions. In Investigation 11.1, students look forward 100 years using the United States Global Change Research Program (USGCRP) report, *Global Climate Change Impacts in the United States* (2014), and explore temperature and precipitation projections for their area. These projections do not have the certainty of predictions, but they will give students a sense of what climatologists expect for their region. The projections also introduce practical issues of climate change that regional planners, health officials, farmers, engineers, and others must consider. In Investigation 11.2, students learn how researchers at the Smithsonian Environmental Research Center simulate higher CO_2 and nitrogen levels and sea level rise expected in the future to monitor their effects on wetlands.

Assessment Lesson

In Lesson 12, you will access the skills and knowledge students have acquired throughout the unit. No teaching or learning of new content is intended; the assessment should be used to measure how far students have come and to diagnose any remaining knowledge gaps or misconceptions. This assessment has two parts: the Performance Assessment and the Written Assessment. In the **Performance Assessment**, students apply the knowledge and skills they have acquired during the unit to analyze data in order to predict future weather conditions. In the **Written Assessment**, students respond to multiple-choice and constructed-response items aligned to concepts covered in this unit.

Teacher Support

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LESSON AT A GLANCE

...ATION 3.4: ...g How Warm Air ...r Move	REFLECTING ON WHAT YOU'VE DONE	*EXTENDING YOUR KNOWLEDGE* READING SELECTIONS
...onduct an ...t to investigate ...ent of air.	• Students review the results of the lesson's investigations and use what they have learned to interpret real-world processes. • Students read Extending Your Knowledge: *Air Masses.*	• *Air Masses* describes different types of air masses. • *What Are Clouds?* describes the formation of clouds.

Lesson 3 **The Water Cycle, Cloud Formation, and Air Masses**

Investigation 3.1: Observing Evaporation and Condensation

Procedure

1. Inform students that in this investigation, they will explore the following question: How does the temperature of water affect evaporation and condensation? Have each student record the question in his or her science notebook. Students should plan to record observations under the question.

2. Show students two plastic bottles, a thermometer, ice cubes, and the beakers of water—one group's set of materials. Point out that one beaker of water is hot and one is cold.

3. Invite groups to share ideas they might have about how to use the materials to investigate the question. If students need additional guidance in designing their investigation, review the following points:

a. Students should measure and record the temperature of each beaker of water before they start the investigation.

b. Instruct students to make and record their predictions. For example, what do they think will happen if they pour hot water into one bottle and cold water into the other and then cap the bottles?

c. Students should control all variables. For example, they should make certain the volume of hot and cold water is the same in each bottle and observe each bottle for the same amount of time.

4. Discuss with students how they will record their predictions and observations. Table 3.1 is an example of how they can be recorded.

5. Have students collect the materials they will need and set them up for the investigation.

continued

NOTE

Set out a bottle of room-temperature water in front of the class for groups to use as...

Investigation 3.1

Observing Evaporation and Condens...

Materials

For you
- Science notebook

For your group
- 1 Colorless 2-L bottle with cap
- 1 Digital thermometer
- 1 Funnel
- 1 Stopwatch
- Beaker of cold water
- Beaker of hot water
- Paper towels
- Scissors

For the class
- 1 Bottle of room-temperature water
- Ice cubes

Procedure

1. How does the temperature of water affect **evaporation** and **condensation**? Record your ideas in your science notebook. Discuss your ideas with the class. Leave enough room to write your observations.
2. Look at the equipment you will use in this lesson to observe changes in water due to warming or cooling. You will explore how the temperature of water affects evaporation and condensation.
3. How would you use the materials to test this question? Share your ideas with the class.
4. Discuss with your teacher how you will record your predictions and observations in a table.
5. Collect your materi... group has planned, ... investigation and re...
6. How does the temp... evaporation and co... the ice cube on the... (See Figure 3.2.) W... on the outside of t... Record your observ... your group.
7. Clean up according...
8. Read Building Your... a *Big Deal.* Then an... in your science note...
   a. What are some ...
   b. What process ch... vapor and wate...

Figure 3.2
Rub an ice cube and ... on the outside of th...

Lesson 3 **The Water Cycle, Cloud Formation, and Air Masses**

Reflecting On What You've Done

1. Encourage students to cite evidence from their investigation as they answer the question. Sample answers are given below:

a. Students may have rubbed an ice cube against the bottle to decrease the temperature of the plastic surface and produce more condensation (moisture). Others may have held their warm hands against the bottle to increase the temperature of the plastic surface and evaporate the condensation on the sides of the bottle.

b. More condensation formed in the bottle with the hot water because hot water evaporates faster than cool water. Hot water evaporated and then condensed again when it touched the sides of the cool plastic bottle.

2. Encourage students to cite evidence from their investigation as they answer the question. Sample answers are given below:

a. Students modeled a similar closed system, in which the lamp stands in for the Sun, providing the energy to drive evaporation and condensation take place and the water does not stay within the measuring cups. This is like Earth's water cycle, in which the same water supply is recycled through evaporation and condensation.

b. The sun provides the energy that drives the water cycle, causing melting of ice and evaporation.

c. Gravity brings liquid water back down to Earth's surface from clouds as precipitation.

d. If heat from the lamp were less direct and farther from the container, there would be less evaporation or it would occur more slowly. If the lamp were closer to the container and more direct, evaporation would occur faster. The same total amount

REFLECTING ON WHAT YOU'VE DONE

1. Answer these questions and then discuss your answers with the class:
   a. In Investigation 3.1, were you able to change the amount of evaporation and condensation that occurred inside your bottles? If so, how?
   b. In which bottle did you observe the most evaporation and condensation? Why do you think that happened?
2. Consider Investigation 3.2. Discuss the following questions with your group, recording the answers in your science notebook. Then discuss the answers with your class.
   a. How does this model relate to the water cycle?
   b. What role does the Sun play in the water cycle?
   c. What role does gravity play in the water cycle?
   d. How do you think this model would be affected if the position of the lamp were changed? Would more or less water have been collected?
   d. How do you think this relates to the process of cloud formation on Earth?
   e. Apply what you observed in this lesson to Earth. If Earth's surface is colder than the air above it, what will happen to the air?
   f. If the surface is hot and damp, what will happen to the air above it?
4. Read Extending Your Knowledge: *Air Masses* and answer the discussion questions. With your teacher's help, develop working definitions for "stable air mass" and "unstable air mass." Record your definitions in your science notebook. Apply what you observed in this lesson to cloud formation. When do you think clouds are more likely to form: when air remains close to Earth's surface or when air rises and moves quickly to high altitudes? Why? Record your answers in your science notebook.
5. Examine the KWL chart that was created in

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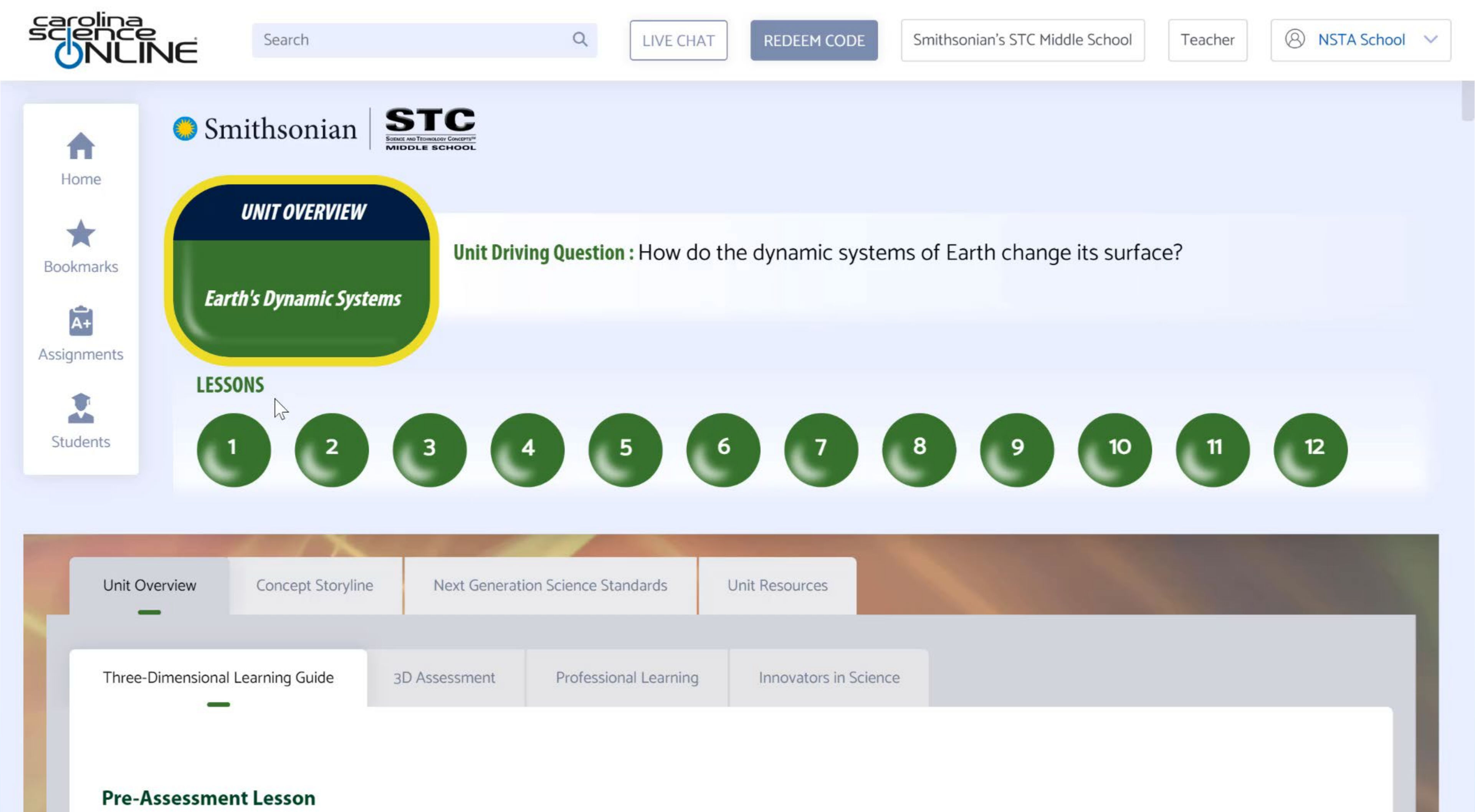

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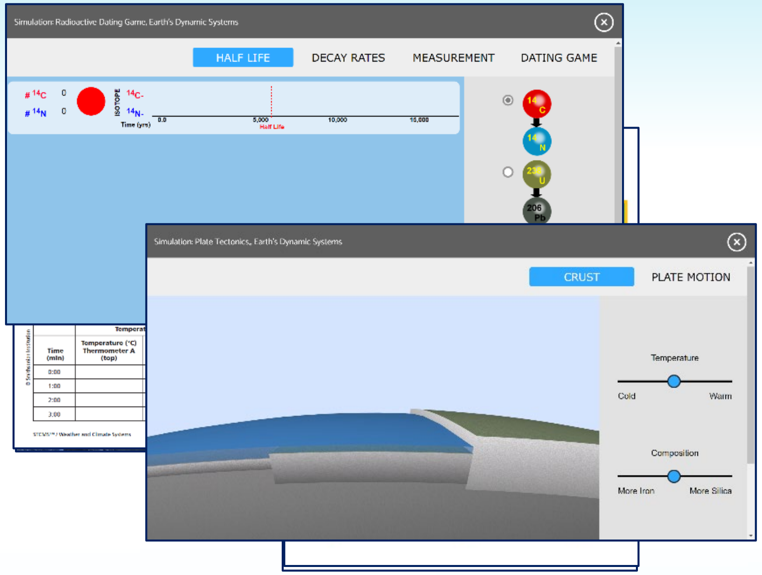

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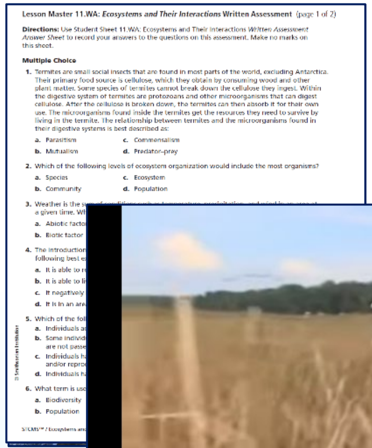
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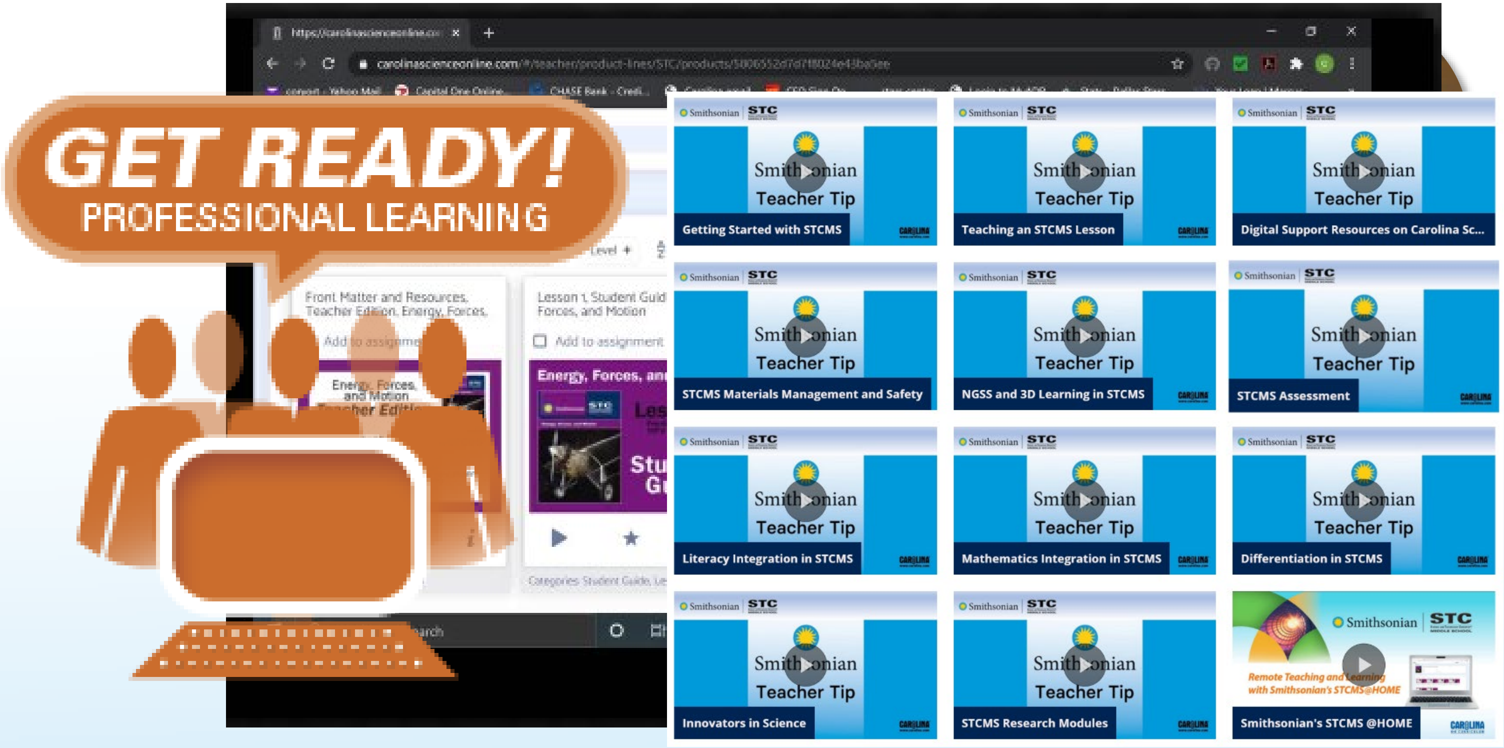

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