NextGenScience

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Keep Teaching Science!

Successful Strategies to Adapt K–12 Science Experiences for Distance Learning

Acknowledgments

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Launched at WestEd in April 2020, NextGenScience works alongside educators to design quality, coherent programs that align science standards, instructional materials, professional learning, and assessments. For more information, visit www.wested.org/project/nextgenscience.

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About This Project

The sudden shift to distance and hybrid learning due to the COVID-19 pandemic created a need to identify virtual and at-home science experiences that reflect the vision of the Next Generation Science Standards (NGSS) and ***A Framework for K–12 Science Education***, ensuring students keep learning science.

NextGenScience partnered with materials developers and educators to learn about and highlight examples of effective and equitable adaptations for science teaching and learning at a distance.

Our Process

Step 1: Identify science materials that have been adapted for distance learning.

Step 2: Evaluate both the in-person and distance materials for key NGSS features, identifying where NGSS features were retained or lost.

Step 3: Analyze trends and highlight examples of adaptations that effectively maintain — and potentially enhance — best practices.

Step 1: Identify Materials

Users and developers have adapted the following units for distance or hybrid instruction. The reviewers selected seven lessons across these units to analyze.

Amplify 3rd Grade Unit: Balancing Forces	mySci 5th Grade Unit: From Sun to Food	OpenSciEd Middle School Unit 6.3: Why Does a Lot of Hail, Rain, or Snow Fall at Some Times and Not Others?	iHub High School Unit: Why Don’t Antibiotics Work Like They Used To?
Middle school materials earned a Green rating from EdReports	Earned high quality rating from Science PRP	Earned high quality rating from Science PRP	Earned high quality rating from Science PRP

Note: *While some of these full units have been reviewed with the EQuIP Rubric for Science by the NextGenScience Peer Review Panel, the evaluation in this document does not constitute a full lesson review for NGSS design. This document is intended to spotlight effective strategies for NGSS design criteria, but is not an endorsement of a specific curriculum or comprehensive of all best practices.*

Step 2: Evaluate Lessons

Reviewers with expertise in the NGSS and high-quality instructional materials conducted an analysis of in-person and distance versions of all seven lessons using the six NGSS Lesson Screener criteria.

- **Explaining Phenomena or Designing Solutions**
- **Three Dimensions**
- **Integrating the Three Dimensions for Instruction and Assessment**
- **Relevance and Authenticity**
- **Student Ideas**
- **Building on Students’ Prior Knowledge**

www.nextgenscience.org/screener

Step 3: Analyze Trends and Highlight Effective Adaptations

Reviewers then looked across all seven lessons to highlight trends, differences, and opportunities.

Strategies to Adapt Science Materials for Distance Learning

The adaptation of existing high-quality science materials for a distance environment can enhance the vision of three-dimensional standards while providing opportunities for students to engage in both distance and hybrid settings.

1. Introduce phenomena through independent pre-work.
2. Ensure all students can experience and explore phenomena as directly as possible.
3. Provide discussion questions in written form to support student development and use of the three dimensions.
4. Provide a central space for students to track three-dimensional thinking and revise ideas over time.
5. Leverage additional home connections.
6. Provide students independent time to formulate questions and ideas to drive the next step in learning.
7. Elicit student ideas through discourse and writing in both synchronous and asynchronous environments.
8. Connect current learning to specific activities from prior lessons across all three dimensions by using pictures when classroom artifacts aren't available.

NGSS Lesson Screener Criterion A

Explaining Phenomena or Designing Solutions

The lesson focuses on supporting students to make sense of a phenomenon or design solutions to a problem.

Explaining Phenomena or Designing Solutions

Strategy 1: Introduce phenomena through independent pre-work.

Quality distance materials help students to explore, wonder, and ask questions about phenomena during independent work time at the beginning of a lesson or unit. This may provide more time for students to make observations, discuss with family, and generate questions to investigate.

> "In a regular classroom, the [Anchoring Phenomenon] routine might last one or two days; as outlined here, it might span multiple days, so that students have time both to generate ideas and build on each others' ideas."
>
> *OpenSciEd Remote Learning Resource: Leading an Anchoring Phenomenon Routine*

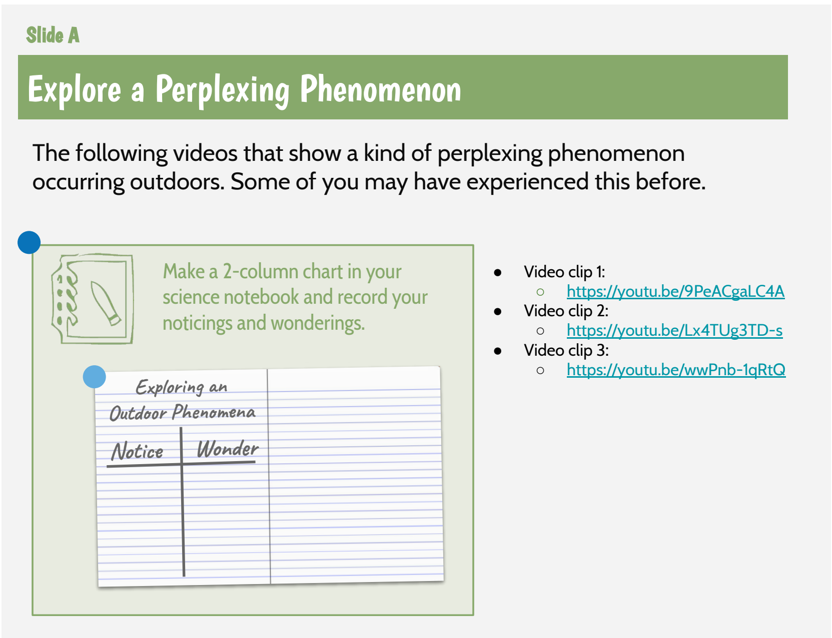
Explaining Phenomena or Designing Solutions

Introduce Phenomena Through Independent Pre-work

OpenSciEd, Unit 6.3, Lesson 1 (Middle school), Adapted by Louisiana Department of Education

In both versions of the lesson, prior experience about the phenomenon is elicited, and learning is driven throughout by students making sense of the phenomenon. By viewing the phenomenon independently at home in the distance version, students may have more time to generate questions in advance of the class discussion.

In-Person Learning

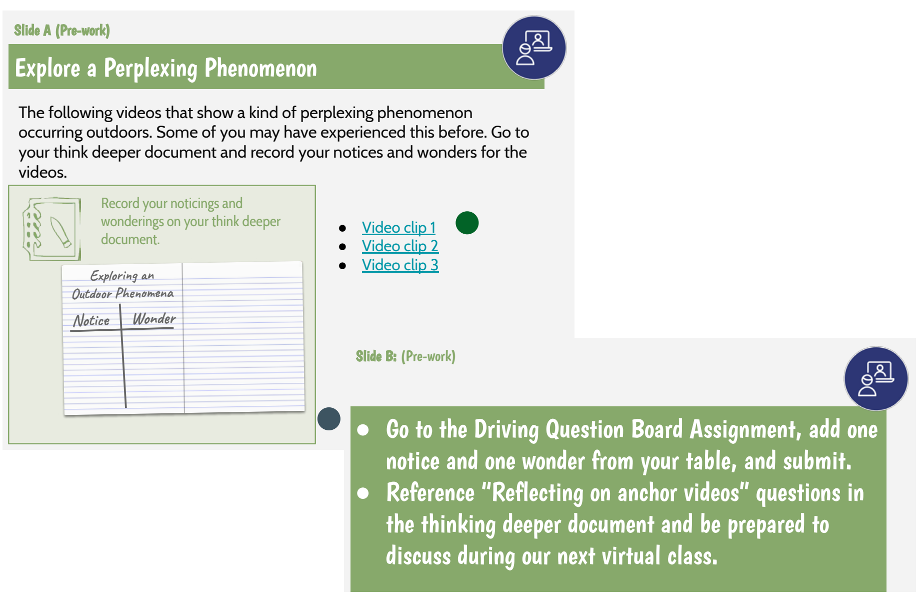


- Students are guided through watching each video and are prompted to record what they notice and wonder between each one, generating a class list.

  The teacher guide provides suggested teacher prompts for class discussion and to elicit student reflections on the anchor video.

- Students have the opportunity to hear and build off of each other's ideas.

Distance Learning



- Students watch the phenomena on videos during independent pre-work and submit what they notice and wonder to the teacher.

  Students potentially have more time to notice and wonder about the phenomenon.

  Videos could be delivered via thumb drive or viewed via YouTube on a phone, but all options require access to a device.

- Thinking Deeper Documents (student handouts) include questions to prompt student written reflection about the anchor video.

Strategy 2: Ensure all students can experience and explore phenomena as directly as possible.

When videos are not available to students, distance materials add pictures so students can experience phenomena as directly as possible. Other materials replace in-person activities with computer simulations, assuming internet access. By adding pictures to the student materials, these materials create additional opportunities for students to experience phenomena as directly as possible.

"Students experience phenomena or design problems as directly as possible (firsthand or through media representations)."

EQuIP Rubric for Science, Criterion II.A. Relevance and Authenticity

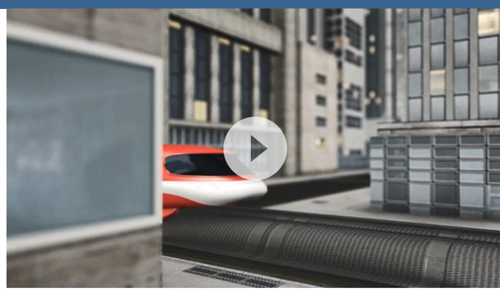
Explaining Phenomena or Designing Solutions

Using Pictures in Place of Videos to Introduce Phenomena

Amplify, Balancing Forces, Lesson 1 (Grade 3)

In both versions of the lesson, the explanation for the phenomenon is not given away, and students begin by developing their initial explanation. In the distance version, students are given printed out screenshots and captions of the phenomenon in case they don't have the ability to watch videos.

In-Person Learning



Lesson 1.1: Pre-Unit Assessment

Activity 1

The train floated up without anything touching it. Later, it fell back down to the track.

We are going to figure out how floating trains work.

Students in class are told a new type of train is coming to a fictional town of Faraday and watch a video of a floating train. In addition, students are given visuals of the floating train.

See video here: bit.ly/FaradayTrain

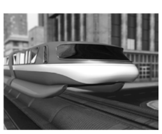
Distance Learning

Amplify Science

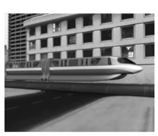
Balancing Forces @Home Lesson 1

INTRODUCING THE FLOATING TRAIN

A **floating train** is coming to the city of Faraday.



The train rises off the track,...



floats...

and then falls back down.

Optional: You can watch a video of the floating train at tinyurl.com/yxclf6qx.

The citizens of Faraday are worried about riding a floating train. The mayor needs us to figure out a **scientific explanation** for how the floating train works so people won't be worried anymore.

We will be student **scientists**. The mayor will share our explanations with the citizens of Faraday.

- Student view screenshot pictures from the video along with text captions of the floating train phenomenon. The students are also given abridged text from the video describing the town of Faraday.
- Video is provided as an option for students with technology. **Some students without video access won't experience the phenomenon as directly.**
- Family resources introducing phenomena are provided to promote at-home discussion (see Strategy 7).

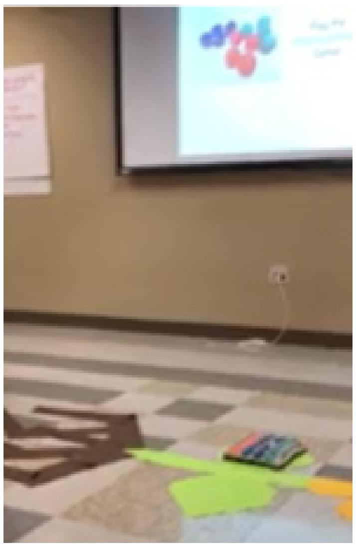
Explaining Phenomena or Designing Solutions

Using Pictures and Simulations in Place of In-person Activities to Explain Phenomena

mySci: From Sun to Food, Lesson 6 (Grade 5)

In both versions, students are working to explain the lesson-level phenomenon: why bean plants without water and without air don't grow. To explain this, they use models (with ping pong balls in person and with a computer simulation for the distance adaptation) to figure out why plants need both carbon dioxide and water (along with energy from the sun) to make glucose.

In-Person Learning



How do growing conditions affect bean growth?

Light, water, & air | **Light & water (no air)** | **Light & air (no water)**

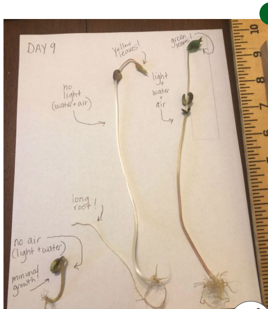
Play the **Photosynthesis** Game

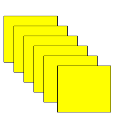
To figure out why certain beans didn't grow from a previous lesson, students interact with a model with ping pong balls representing atoms (hydrogen, oxygen, and carbon) in an in-class activity.

Distance Learning

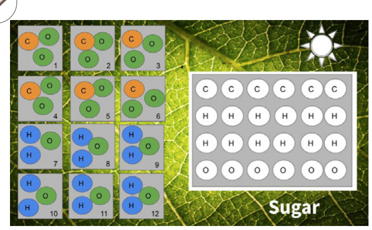
If you're watching a video of this lesson asynchronously, use the pencil icon to let you know when to record something in your science journal.

Look at the results from this bean plant experiment. The beans were grown in plastic bags with no soil- only cotton balls around the beans to support them. There is one bean not pictured- the bean with no water didn't even sprout. What do you notice and wonder about these results?





Sticky note norms:
-One question/idea per sticky.
-Put your initials.
-Add a +1 if you have the same question/idea as a peer.
-Move stickies around, don't pile them up.



- A photo replaces an in-class experience to introduce the lesson-level phenomenon.
- Students use a click-and-drag Google Slides simulation with interactive atoms.

The simulation adaptation provides structure for the student to explore the model individually.

Three Dimensions

The lesson helps students develop and use multiple grade-appropriate elements of the Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCCs), which are deliberately selected to aid student sense-making of phenomena or designing of solutions.

Strategy 3: Provide discussion questions in written form to support student development and use of the three dimensions.

Although there are decreased face-to-face, synchronous discussions to propel student thinking, distance materials take advantage of opportunities to push thinking in similar ways through well-crafted, written prompts. Materials provide student slides and handouts with clear, scaffolded questions designed to acquire, improve, or use grade-appropriate elements of the Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCCs) to help explain phenomena or solve problems. This can provide time for students to think deeply about their knowledge and skills and can create an artifact of their current understanding across dimensions.

Three Dimensions

Scaffolds to Support SEP Development

OpenSciEd, Unit 6.3, Lesson 5 (Middle school), Adapted by Louisiana Department of Education

Both versions engage students in the practices of **Planning and Carrying out Investigations** and **Developing and Using Models**. The investigation is followed by a whole-class conversation and development of a student-generated model. In the distance version, students who are unable to complete the investigation at home still engage in critical sense-making.

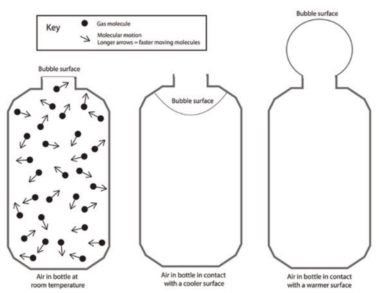
In-Person Learning

Soap Bubble and Bottle Investigation

1. When representing the molecules that make up the air in the closed bottle system after cooling and after warming, how many dots should you draw? Why?

2. How did changing the temperature of the air in the closed bottle system affect the molecules that made up the air?

3. Use the above ideas to represent changes in the behavior of the molecules that made up the air in the closed bottle system when you cooled and warmed it. As you work on your models, consider the following elements:
   - the number of molecules that make up the air in each bottle system
   - the length of the arrows to represent the speed of the molecules that make up the air in each bottle system
   - the amount of space between the molecules that make up the air in each bottle system



Distance Learning

Thinking Deeper Weather Lesson 5

Soap Bubble Investigation Predictions and Observations (Slide C)

1. What do you think will happen to the air in the bottle when it is in contact with the cold water? Why?

2. What do you think will happen to the air in the bottle when it is in contact with the hot water? Why?

3. Observations of the Soap Bubble Investigation

Soap Bubble Investigation (Slides E-G)

3. When representing the molecules that make up the air in the closed bottle system after cooling and after warming, how many dots should you draw? Why?

4. How did changing the temperature of the air in the closed bottle system affect the molecules that made up the air?

Resources adapted from OpenSciEd with permission under Creative Commons 4.0

5. Use the above ideas to represent changes in the behavior of the molecules that made up the air in the closed bottle system when you cooled and warmed it. As you work on your models, consider the following elements:
   - the number of molecules that make up the air in each bottle system
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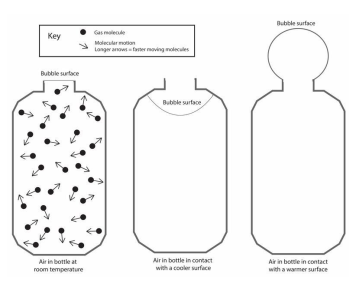

6. What is density?

7. When we placed the bottle in cold water, what happened to the air inside the bottle?

8. When we placed the bottle in hot water, what happened to the air inside the bottle?

Resources adapted from OpenSciEd with permission under Creative Commons 4.0

Planning and Carrying Out Investigations 6–8 element: *Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation.*

Developing and Using Models 6–8 element: *Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*

Investigation is completed independently at home. A *video* is provided for those who cannot complete it. If students only watch it, they aren't meeting the "*conduct an investigation*" part of the SEP, but they can still use observations and data from the investigation as the basis for evidence.

Developers prioritized sense-making over the hands-on experience.

Three Dimensions

Scaffolds to Support DCI Development

OpenSciEd, Unit 6.3, Lesson 5 (Middle school), Adapted by Louisiana Department of Education

In both versions, this investigation is followed by a discussion on density and a connection to the unit phenomenon that helps to develop core ideas about weather and matter and properties of matter. In the distance version, converting the in-person discussion questions to an individual task paired with a shared discussion board allows all students to participate more deeply in the discussion.

In-Person Learning

Soap Bubble and Bottle Investigation

1. When representing the molecules that make up the air in the closed bottle system after cooling and after warming, how many dots should you draw? Why?

2. How did changing the temperature of the air in the closed bottle system affect the molecules that made up the air?

3. Use the above ideas to represent changes in the behavior of the molecules that made up the air in the closed bottle system when you cooled and warmed it. As you work on your models, consider the following elements:
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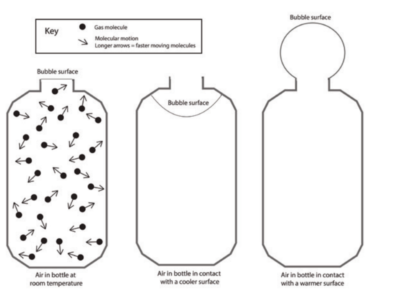
   - the amount of space between the molecules that make up the air in each bottle system



In-person student handout is accompanied by class discussions to propel student thinking on DCI concepts.

PS1.A 6–8 element: *The fact that matter is composed of atoms and molecules can be used to explain the properties of substances, diversity of materials, states of matter, phase changes, and conservation of matter.*

ESS2.D 6–8 element: *Complex interactions determine local weather patterns and influence climate, including the role of the ocean.*

Distance Learning

Thinking Deeper Weather Lesson 5

Soap Bubble Investigation Predictions and Observations (Slide C)

1. What do you think will happen to the air in the bottle when it is in contact with the cold water? Why?

2. What do you think will happen to the air in the bottle when it is in contact with the hot water? Why?

3. Observations of the Soap Bubble Investigation

Soap Bubble Investigation (Slides E-G)

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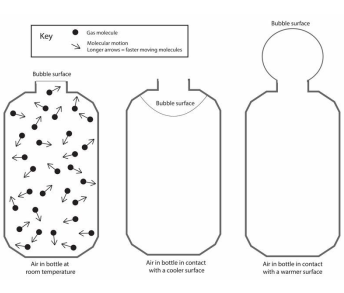

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8. When we placed the bottle in hot water, what happened to the air inside the bottle?

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Student handouts include discussion prompts from the in-person version and are posted to a shared discussion board.

This is more likely to result in a multi-dimensional artifact of students' current understanding of the DCI than the in-person full class discussion.

Reflection questions are added to push student thinking about PS1.A before the virtual class discussion.

Three Dimensions

Scaffolds to Support CCC Development

OpenSciEd, Unit 6.3, Lesson 5 (Middle school), Adapted by Louisiana Department of Education

Both versions provide prompts to support the use of the **Systems and System Models** element and opportunities to develop a **Cause and Effect** element by making predictions before the investigation (via student notebooks in person and questions in distance handout), as well as by using evidence from the investigation to predict the effect of thermal energy transfer to the air in contact with Earth's surface to help explain the unit phenomenon of hailstorms. In the distance version, students have specific written prompts to make and reflect on these predictions and consider the features of a closed system.

In-Person Learning

Soap Bubble and Bottle Investigation

1. When representing the molecules that make up the air in the closed bottle system after cooling and after warming, how many dots should you draw? Why?

2. How did changing the temperature of the air in the closed bottle system affect the molecules that made up the air?

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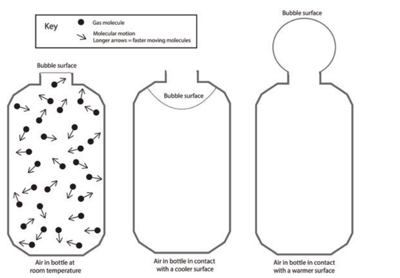

The teacher guide states, "you may want to spend a little time reminding students that matter cannot enter or leave a closed system. However, energy can enter and leave a closed system. Both of these ideas were developed in the Cup Design Unit," reinforcing **Systems and System Models**.

It is unclear when this reminder might happen in the distance version.

Cause and Effect 6-8 element: *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*

Systems and System Models 6-8 element: *Models can be used to represent systems and their interactions — such as inputs, processes and outputs — and energy, matter, and information flows within systems.*

Distance Learning

Thinking Deeper Weather Lesson 5

Soap Bubble Investigation Predictions and Observations (Slide C)

1. What do you think will happen to the air in the bottle when it is in contact with the cold water? Why?

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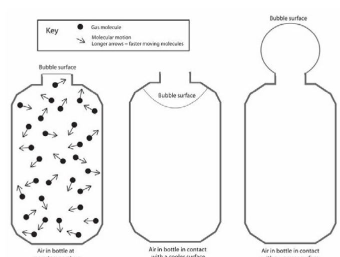

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Students have additional opportunity to make more specific predictions (questions one and two) and to reflect on their **Cause and Effect** predictions (questions seven and eight) before the virtual class discussion.

NGSS Lesson Screener Criterion C

Integrating the Three Dimensions for Instruction and Assessment

The lesson requires student performances that integrate elements of the SEPs, CCCs, and DCIs to make sense of phenomena or design solutions to problems, and the lesson elicits student artifacts that show direct, observable evidence of three-dimensional learning.

Integrating the Three Dimensions for Instruction and Assessment

Strategy 4: Provide a central space for students to track three-dimensional thinking and revise ideas over time.

In a science classroom, science notebooks and bulletin boards are important structures that invite students to share their thinking and track how ideas change over time. Some distance materials use an incremental modeling tracker, graphic organizer, or similar document that allows students to record new ideas about phenomena using multiple dimensions and reflect on how their understandings shift over time.

Integrating the Three Dimensions for Instruction and Assessment

Track Thinking in a Central Space

InquiryHub, Unit: Why Don't Antibiotics Work Like They Used To? Lesson 4 (High school), Adapted by Louisiana Department of Education

In both versions, the Incremental Modeling Tracker guides students to address overarching questions, determine what new learning was obtained, and identify opportunities to revise the initial model based on what they learned in the lesson. This structure encourages students to use multiple dimensions (i.e., look for patterns that help them explain their observations, analyze data, and construct and revise a model). **Students are regularly prompted to update their tracker to explain the unit phenomenon after developing new knowledge and skills, which can create a multi-dimensional student artifact for individual students.**

Combined with key questions, this tracker can support additional three-dimensional formative assessment opportunities *(e.g., "Imagine there were millions of bacteria on a surface that was dirty, and then it was cleaned. If there were still a few bacteria left alive on that surface, what do you expect would happen to those bacteria? Think back to the petri dishes that we investigated.")*. If students use their Incremental Modeling Tracker as a source of evidence to address the prediction, **this could create individual student artifacts of valuable three-dimensional thinking.**

In-Person Learning

Incremental Modeling Tracker (IMT) UPDATE:

3. What did we figure out? Which parts of what we figured out (if any) can help us with our model? How can we add to revise our models? Record your current thinking about these questions on your IMT.

LESSON QUESTION (What Question Are We Trying to Answer?) & LESSON NICKNAME	WHAT DID WE FIGURE OUT? Which parts of what we figured out (if any) can help us with our model? (Highlight them!)	BASED ON OUR PROGRESS THIS LESSON, HOW CAN WE ADD TO OR REVISE OUR MODEL? How should we represent our ideas in our model? (Use pictures, words, or symbols)

Students access paper handout tracker.

- Tracker questions are used to prompt discussion in person.

Distance Learning

Incremental Modeling Tracker:

Driving Question: Why is it that Addie got sick, then got a little better, then sick again, then a little better, then eventually VERY sick?

Lesson Question (What question were we trying to answer - refer to the beginning of the slideshow if needed)	**What did we figure out?** (in this blank, explain what you learned in this lesson. Then highlight which parts might help you revise your model)	Based on our progress in this lesson, how can we **add to or revise our model**? How should we represent our ideas in our model?
type here	***type here***	***type here***

Students access tracker both embedded on slide deck and as a paper handout.

- Students type directly into each lesson's slide deck to submit to the teacher.

  The teacher guide recommends giving students a printed tracker handout for use without internet so students can keep a record.

- Additional student handouts provide tracker questions in written form for independent work in the distance version.

NGSS Lesson Screener Criterion D

Relevance and Authenticity

The lesson motivates student sense-making or problem-solving by taking advantage of student questions and prior experiences in the context of the students' homes, neighborhoods, and communities as appropriate.

Relevance and Authenticity

Strategy 5: Leverage additional home connections.

Distance lessons provide additional opportunities for students to more deeply connect aspects of the phenomenon with their home and community. This connection could make the phenomenon more relevant and increase motivation to engage.

"The use of ***culturally relevant examples***, analogies, artifacts, and community resources that are familiar to learners can make science more relevant and understandable (Barba, 1993), and integrated approaches that ***rely on the input of community member participation*** (e.g., input from elders, use of traditional language, respect of cultural values) ***help learners navigate*** between Western modern scientific thinking and other ways of knowing (Bang and Medin, 2010)."

Learning Through Citizen Science, The National Academies of Sciences, Engineering, and Medicine, 2018

Relevance and Authenticity

Additional Home and Community Connections

InquiryHub, Unit: Why Don't Antibiotics Work Like They Used To? Lesson 4 (High school), Adapted by Louisiana Department of Education

In both versions, lessons take advantage of prior experiences in the context of students' homes and communities, motivating student sense-making of the phenomenon using those connections. In the distance version, conversations with family replace a written survey, potentially deepening these connections and the relevance of their science instruction.

In-Person Learning

Lesson 3:

FOR HOME-LEARNING: Pass out paper copies (or use a Google form) to complete a survey that you administer to your family and people you interact with about their use of antibiotics. Tomorrow we will see what our community has to say.

Lesson 4:

CONNECTING TO THE PREVIOUS LESSON:

- **1. What did your friends and relatives report about their use of and experience with antibiotics?**

- Students ask friends and family to fill out a written survey, then have a whole-group class conversation about the answers and track them on the board. Students are able to hear family connections from other students and see trends, elicit questions, then connect those trends to the next part of the storyline. **Hearing other student family connections has the potential to broaden perspectives.**

Distance Learning

- **Talk to some of your friends and family members about the following, then summarize your conversations in the box below.**
  1. **When you have been sick in the past and got prescribed antibiotics, do you know where you picked up the bacteria?**
  2. **What type of antibiotics did you take and for how long?**
  3. **Did you take all your prescribed medicine, or did you stop when you felt better?**

- Students have *conversations* with friends and family and record answers themselves rather than asking others to fill out a written survey. This takes the place of a class-wide conversation about these connections.

This enhanced opportunity to engage in discussion with family and friends has great potential to connect the phenomenon to relevant family/community values and interests while using the language with which they are most comfortable.

Strategy 6: Provide students independent time to formulate questions and ideas to drive the next step in learning.

Although students aren't in a face-to-face classroom environment to easily share questions, distance materials give the opportunity for students to develop their own questions and wonderings about the phenomenon or problem and position the teacher to use these wonderings to frame, motivate, and drive the next step in learning from the students' perspectives.

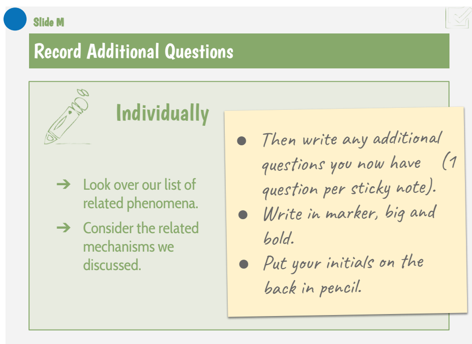
Relevance and Authenticity

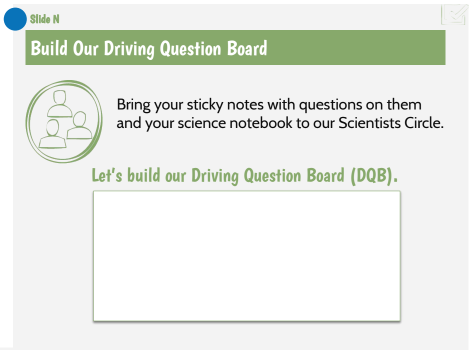
Student Questions and Ideas Drive Learning

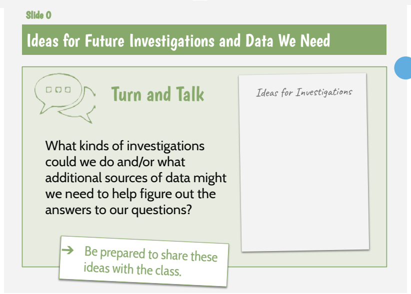
OpenSciEd, Unit 6.3, Lesson 1 (Middle school), Adapted by Louisiana Department of Education

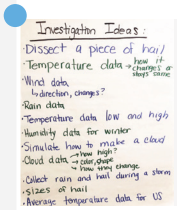
In both versions, the end of the lesson provides an opportunity for the teacher to see student questions and ideas and use them to connect to the next lesson's investigation and sense-making. Students see that their questions are being investigated and answered during the learning process, promoting a sense of agency and belonging.

In-Person Learning







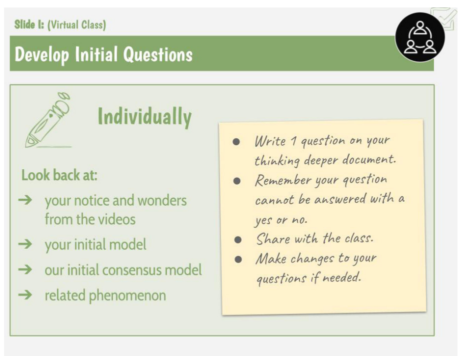


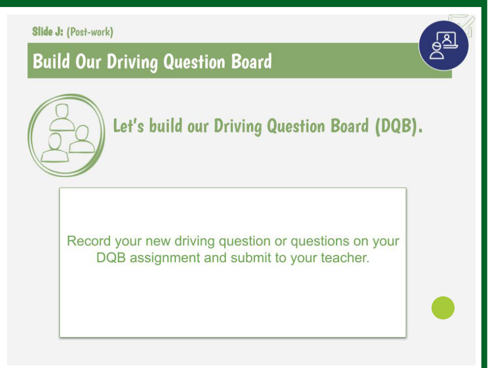
Students share and hear each other's individual questions, then work together to create and organize their questions on the class Driving Question Board.

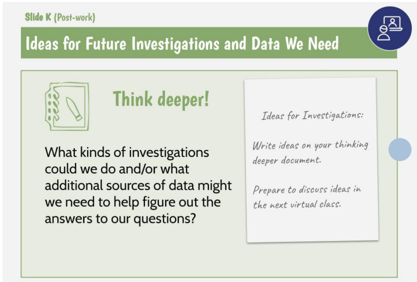
Students share ideas for future investigations and make a class list. The teacher is asked to prioritize one set of ideas for the next class investigation (e.g., "I noticed many of our questions were about how hail formed.").

Virtual class
Students share questions, hear other students' questions, and make changes to their questions as needed.

Distance Learning







Independent work
Students are responsible for submitting questions and ideas in their Thinking Deeper Document to the teacher. **Students may have more time to generate thoughtful questions and ideas during independent work.**

The teacher organizes submitted student questions on the Driving Question Board before the next virtual classes.

The teacher uses ideas for future investigations at the beginning of the next lesson to drive the learning. **This structure allows students to see their questions and ideas are important because their questions are driving the learning.**

NGSS Lesson Screener Criterion E

Student Ideas

The lesson provides opportunities for students to express, clarify, justify, interpret, and represent their ideas (i.e., making thinking visible) and to respond to peer and teacher feedback.

Student Ideas

Strategy 7: Elicit student ideas through discourse and writing in both synchronous and asynchronous environments.

A classroom environment allows students to more easily express, clarify, justify, interpret, and represent their ideas and to respond to peer and teacher feedback orally and in written form as appropriate. Distance materials provide students with opportunities for discourse and guidance for both teachers and families to elicit student ideas, focusing on expressing and clarifying student reasoning. While sharing written ideas, students have opportunities to write text or draw to show their thinking.

> "A classroom environment that provides opportunities for students to participate in scientific and engineering practices engages them in tasks that require social interaction, the use of scientific discourse (that leverages community discourse when possible), and the application of scientific representations and tools."
>
> *A Framework for K–12 Science Education, The National Academies of Sciences, Engineering, and Medicine, 2012*

Student Ideas

Encourage Student Discourse

Amplify, Balancing Forces, Lesson 2 (Grade 3)

In both versions, discourse is encouraged reinforcing that student ideas are valued.

In-Person Learning

Think-Pair-Share Routine

Think
Think silently about the question.

Pair
Turn and talk to a partner about the question.

Share
Share your ideas about the question with the class.

What do you think could make a train **rise up** off the track?

What do you think could make a train **float above** the track?

What do you think could make a train **fall back** onto the track?

What questions do you have about the floating train?

Students discuss their ideas with a partner, then share ideas in a full-class discussion.

Distance Learning

Amplify Science
Balancing Forces @Home Lesson 2

Remember we are student scientists investigating what can make things (like the floating train) move, float, and fall.

TALK

Use the Think-Pair Routine to discuss each question.

1. What do you think could make a train rise up off the track?
2. What do you think could make a train float above the track?
3. What do you think could make a train fall back onto the track?
4. What questions do you have about the floating train?

Think-Pair Routine

Think
Think silently about the question.

Pair
Talk to your partner about the question. Your partner can be a family member, a friend on the phone, or even a pet or stuffed animal!

FAMILY GUIDANCE

In the *Balancing Forces* unit, **students learn about a kind of train that floats as it speeds along**. Students figure out ideas about magnetic force, gravity, and movement as they investigate and explain how the train works.

We are using a version of Balancing Forces that is specially designed for at-home learning. It gives students many opportunities to consider different questions about the floating train, gather evidence to help them understand, then use that evidence to make explanations. **This means students will be doing activities that involve talking, writing, reading, and investigating.**

In order to support your student, you can help them with reading and understanding directions, **talking over questions and ideas**, doing hands-on activities using things that you may have at home, **writing about their ideas**, and reading books. (*emphasis added*)

TEACHER GUIDANCE

Student talk options

- Talk to someone in their household about their ideas.
- Talk to a stuffed animal about their ideas.
- Call a friend or classmate and discuss their ideas.
- Talk in breakout groups in a video class meeting.
- (For older students) use asynchronous discussion options on technology platforms.

- The Think-Pair Routine has been enhanced to include a variety of partner options providing flexibility for students' situations. **This could encourage multiple conversations.**
- Family guidance introduced the unit phenomenon and encouraged at-home discussion.
- Options to support and facilitate student discourse are provided to the teacher to fit their needs.

Student Ideas

Breakout Room Norms for Virtual Conversations

mySci: From Sun to Food, Lesson 6 (Grade 5)

In both versions, students are given multiple ways to demonstrate learning (talking, writing, drawing). In the distance adaptation, additional norms and roles in breakout rooms encourage all students to share ideas with their peers and listen to the ideas of others.

In-Person Learning

EXPLAIN

Give Students time to answer the questions on the Photosynthesis page (Student Page 16). You may want to allow students to work in pairs or small groups on these questions, then share out. You could also use Post-it journal notes and chart paper to get a sense of what all students are thinking.

1. What **matter** did the plant need to take in to do photosynthesis?
2. What **energy** did the plant need to take in to do photosynthesis?
3. What did the plant make during photosynthesis?
4. How are the experiment we have done with beans and the photosynthesis game related? How did the game help you understand why some plants grew better than others in the experiment?

Teacher guidance gives several options for students sharing ideas:

- Work in pairs, then share out.
- Use Post-It journal notes and chart paper around the room.

The form is designed so students can write text or draw to share their thinking.

Distance Learning

Photosynthesis Model Reflection

1. You will go to a small group breakout room to discuss five questions.
2. You will have 15 minutes to discuss these questions.
3. Choose a recorder, a timekeeper, and a reporter.
   a. Recorder: Types answers.
   b. Timekeeper: Keeps track of the 15 minutes.
   c. Reporter: Will share answers with the whole class when we get back together.

Photosynthesis Model Reflection

1. What were the inputs and outputs of matter in the plant system?
2. What energy did the plant need to start this process?
3. What did you observe about the amount of matter in the model?
4. In real life, what happens to the oxygen that was left over?
5. Why did the beans with no water and no air grow poorly?

Breakout room norms:

-Discuss the questions on the slide with your group.

-Give everyone a chance to speak.

-If you agree, let your peers know. If you disagree with what they say, you can say "I disagree-I think ___ because___."

-Record your final answers in red text on the slide.

Breakout Room 1

Student roles, norms, and sentence stems encourage equitable talk and respectful feedback to peers.

A recorder types each group's ideas, and a reporter is designated to share them with the whole class after virtual breakout rooms. The flexibility to draw answers is removed with this adaptation.

Student Ideas

Flexibility for Sharing Ideas

Amplify, Balancing Forces, Lesson 1 (Grade 3)

In both versions, students have opportunities to draw or write to begin their initial explanation of the phenomenon. In the distance version, teacher guidance provides additional options to elicit student ideas at home, giving students multiple ways to demonstrate their learning.

In-Person and *Distance Learning*

Pre-Unit Writing: Explaining the Floating Train

Why does the train rise? Explain what you think could have made this happen.

Make a drawing if it helps you explain your thinking. Label your drawing.

In the in-person version, students do not have to take additional action to provide the teacher with an artifact (e.g., take a picture and send it in).

A student handout is provided in both in-person and distance versions.

Distance Learning

TEACHER GUIDANCE

Student writing options

- **Write in a designated science notebook.**
- **Photograph writing and submit digitally.**
- **Complete prompts in another format. (Teachers can convert prompts so they are completed in an online survey or an editable document so students can submit digitally.)**
- **Submit audio or video responses digitally, rather than submitting a written response.**
- **Share a response orally with a family member or friend with no submission required.**
- **Complete additional optional Daily Written Reflection *Balancing Forces* Investigation Notebook pages. (These are not included as part of @Home Lessons, but as the teacher, you may consider adding these additional prompts.)**

Teacher guidance for the distance version provides a variety of options to support and facilitate student writing and sharing ideas. Some options do not create a student artifact.

These options can allow students to share ideas in ways that work best for them.

NGSS Lesson Screener Criterion F

Building on Students' Prior Knowledge

The lesson identifies and builds on students' prior learning in all three dimensions in a way that is explicit to both the teacher and the students.

Building on Students' Prior Knowledge

Strategy 8: Connect current learning to specific activities from prior lessons across all three dimensions by using pictures when classroom artifacts aren't available.

When science learning happens over time, students use classroom artifacts and discussions to connect prior knowledge and learning. When artifacts from past experiences are not available (i.e., physically located in the classroom), distance materials suggest using photos, videos, sample data, targeted questions, or models of previous student work to support students to build on their prior knowledge.

Building on Students' Prior Knowledge

OpenSciEd, Unit 6.3, Lesson 1 (Middle school), Adapted by Louisiana Department of Education

In both versions, students are reflecting on prior learning across multiple dimensions: How they used a model to show their understanding of what was happening to the matter and energy in a system. Students then immediately apply this by creating a model of their initial explanation of the phenomenon, "What causes this kind of precipitation to occur?" Eliciting this prior knowledge supports a more coherent experience and enables students to build on all three dimensions.

In-Person Learning

TEACHER GUIDANCE

Bring out any posters from the previous Cup Design Unit that summarize ways to represent what was happening to the matter and energy in the cup system. An example is shown here.

If you do not have these records from that unit, develop a diagrammatic representation of the Cup Design Unit's main ideas for the class to refer to. Use the conventions you developed with your students for representing these ideas.

Slide C

Connect to Ideas from Our Prior Unit

In our Cup Design Unit, we developed ways to represent what was happening to the matter and energy in a system. Let's review them, so we can figure out whether those ideas could help us explain what caused some of the changes happening outside during these precipitation events.

Turn and Talk

- How did we represent the particles that make up different states of matter in a gas, a liquid, and a solid?
- How did we represent the different ways that energy can be transferred into and out of a system like a cup with liquid in it?

→ Be prepared to share your responses with the class.

Students reflect on their prior learning through a turn and talk followed by a whole class discussion.

Distance Learning

Slide C: (Virtual Class)

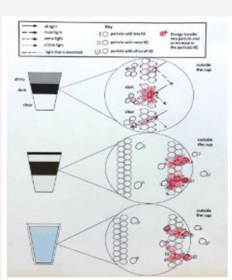
Phenomenon and Connecting Ideas from Our Prior Unit

- Class discussion of notice/wonder charts.
- In our Cup Design Unit, we developed ways to represent what was happening to the matter and energy in a system. Let's review them, so we can figure out whether those ideas could help us explain what caused some of the changes happening outside during these precipitation events. (Slide D)

- Open your Thinking Deeper Document. If you have a paper copy you may reference and answer there.

Students are asked to reference their models from the thermal energy unit but are also provided with a sample model in case this is not available to them.

Slide D: (Virtual Class)
Review of student models for the Thermal Energy Unit.



- Reference your models from the thermal energy unit. If you don't have it you can use the example shown on the left.
- How did we represent the particles that make up different states of matter in a gas, a liquid, and a solid?
- How did we represent the different ways that energy can be transferred into and out of a system like a cup with liquid in it?

→ How might this apply to the videos?

Students answer these questions in their Thinking Deeper Documents rather than through a turn and talk.

Considerations for Supporting Teachers in a Distance Environment

Access to high quality materials is not enough to ensure success in science teaching and learning in this new environment. The following section lays out additional considerations we heard from developers, researchers, educators, and professional learning providers.

> "Ultimately, the task of realizing this vision rests with teachers. To provide students these opportunities, teachers will need new knowledge of the ideas and practices in the disciplines of science, an understanding of instructional strategies that are consistent with the NGSS vision, and the skill to implement those strategies in their classrooms."
>
> *Science Teachers' Learning, National Academies of Sciences, Engineering, and Medicine, 2015*

Advice for School and District Leaders to Support Educators

The following seven considerations stemmed from conversations with developers, researchers, educators, and professional learning providers.

Start with high-quality materials, but don't use in-person materials as designed. They will require adapting to ensure Lesson Screener criteria are considered, and the pacing will need to change significantly. Teachers need planning time to make adjustments for hybrid or distance environments, even with high quality curriculum in hand.

Slow down and prioritize sense-making, even if it means covering less content. Due to the limitations of remote teaching, teachers might feel trapped into information delivery and regurgitation to "cover" what they normally teach. Sacrificing quality for quantity will not lead to success and will only exacerbate inequities. If educators rush things and try to fit in too much, engagement will go down, potentially compromising the ability to incrementally build understanding on a path towards mastery. In addition, making cuts in order to "cover" content quickly could also mean "cutting" engagement in SEPs and CCCs, which would then mean loss of three dimensionality.

At the end of the school year, document the standards with which students were and were not fully engaged (across all three dimensions). The teacher in the following year can use that information to support students with scaffolds as they continue with grade-appropriate learning.

Leverage cross discipline opportunities. All students should receive science instruction. One way to do that is to leverage connections with mathematics and English language arts.

Encourage building community and communicating often with students. Better relationships mean better engagement. A focus on authentic student questions can build relationships, engage in the practice of asking scientific questions, encourage curiosity and wonder, and lead to phenomena to investigate. Students might have the extra time and space they need to bring competing ideas and engage in discourse in ways they otherwise wouldn't. This includes the adults in the students' homes as well, especially if students are being asked to discuss science topics with their family members.

Facilitate collaboration among teachers. Teachers should not have to do this alone. Consider flexibility in the classroom/teacher structure and find creative solutions, especially for teachers preparing to teach similar content.

Plan for Flexibility. Flexibility is key in this environment to provide time for essential community building and appropriate pacing. This means not expecting educators to cover everything and instead to focus on meaningful sense-making with home connections rather than prioritizing power standards or DCIs. Two ways to support this might include:

- **Routines.** A focus on learning and using effective routines is a way to balance structure with student choice, helping to build instruction around things meaningful to students (see OpenSciEd remote routine resources here).
- **Fewer scheduling constraints.** Take advantage of having fewer constraints in the traditional school day and use innovating scheduling that works best for everybody. This is a great opportunity to emphasize what truly matters in school.

Focus less on diagnostic assessments and more on formative assessments. Checking in on what students know and can do formatively to inform instruction is particularly meaningful in this environment. Consider innovative assessments that are equitable and rigorous, such as portfolios, project-based tasks, or video check ins. This can provide opportunity to build in "just in time" supports for student accessibility while continuing with grade-appropriate content.

Technology Considerations for Educators, Schools, and Districts

The following five considerations address technology considerations for a distance learning environment.

1 **Professional learning should model effective distance learning techniques.** To both facilitate effective educator learning and to provide an example educators can apply to instruction, professional learning should use high-leverage strategies, formats, and pacing.

2 **Equitable access.** It's important to find out and plan for technology that teachers and students have available. Offer low technology and no internet solutions as much as possible so all students can be engaged. (e.g., flash drives instead of assuming internet access). Find attainable materials for anything that can be explored and investigated at home. While this is important, instruction design can also ideally provide online opportunities for students who have access.

3 **Technology.** Teachers should be given time and support to navigate new tools. Ideally, this learning would include experiencing new tools in the context of content-specific professional learning.

4 **Limit your collaborative learning tools.** Too many tools (e.g., Padlet, Jamboard, Google Docs, Yammer, Edmodo, Classcraft, MURAL) can be overwhelming and time-consuming for teachers, students, and caregivers alike, and limiting to one or to two tools to support collaboration can create a more coherent experience. On the other hand, educators should continue to communicate with students with any and all means possible (text, email, phone calls).

5 **Use criteria that matter to select online tools.** Consider looking beyond whether a tool is flashy and determine how well it supports:

- Making the learning accessible to all students;
- Making thinking visible;
- Helping students learn from each other; and
- Placing the value on the learning, through sense-making of phenomenon or designing solutions, and not the tool itself.

References

The following are links to all materials, resources, and research referenced throughout the document.

Science Instructional Materials

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  OpenSciEd Unit 6.3: Why Does a Lot of Hail, Rain, or Snow Fall at Some Times and Not Others? (2020). Retrieved from www.nextgenscience.org/resources/middle-school-openscied-unit-63-why-does-lot-hail-rain-or-snow-fall-some-times-and-not
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Additional Resources

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