twig Science

Designed for NGSS: Foundations

Analyze Evidence

Directions:

1. Review your assigned materials to describe the path of student thinking.
2. Represent your answers to the questions in the space provided.
3. Be prepared to share the path of student thinking visually on a public chart.

Answer (in words, graphics, or both)
Answer the following questions as you describe the path of student thinking in the materials. Consider what you would expect students to be thinking about through the learning experiences. What are students figuring out/solving? A. What is driving student learning (e.g., question, scenario, problem, phenomenon, etc.)? B. What ideas and practices do students develop through these experiences? C. How do students access, engage, and use prior knowledge to further their thinking? D. How do students develop metacognitive abilities?
SW1. Phenomena/Problems. Student learning is driven by figuring out a solution to the Module Investigative Problem: How can we reduce the damage caused by earthquake?

Students work through a series of Driving Questions (DQs) that require them to make sense of a subset of smaller phenomena/problems and then connect what they now know to the central problem. The skills and knowledge gained over these investigations culminate in a final class discussion where they address the Module Investigative Problem.

- DQ1: How are waves involved in earthquakes?
- DQ2: How can patterns help us predict where earthquakes and volcanoes will occur?
- DQ3: How can building materials and shapes affect the severity of earthquake damage?
- DQ4: How can our understanding of earthquakes and materials help us build safer buildings?
- DQ5: What can we learn from engineers that will help us revise our designs?
- DQ6: How can we redesign our buildings to make them safer during earthquakes?

Interwoven with this science narrative is a storyline that requires students to take on the role of engineers and design their own earthquake-proof structure. They are introduced to the storyline through a movie-style module trailer.

The Module is complemented with *Shake, Rattle, and Roll*, a magazine-style leveled reader (available in four levels and Spanish) that provides additional exposure to relevant phenomena/problems as well as an interview with a seismologist. Packed with stunning images, cartoons, and jokes, it's designed to appeal to students with a diverse range of learning abilities.

Module trailer

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Evidence of Phenomena/Problems.

- In DQ1 (TB pp. 5-12), students investigate into the phenomenon of wave amplitude and wavelength using water, ropes and an interactive.

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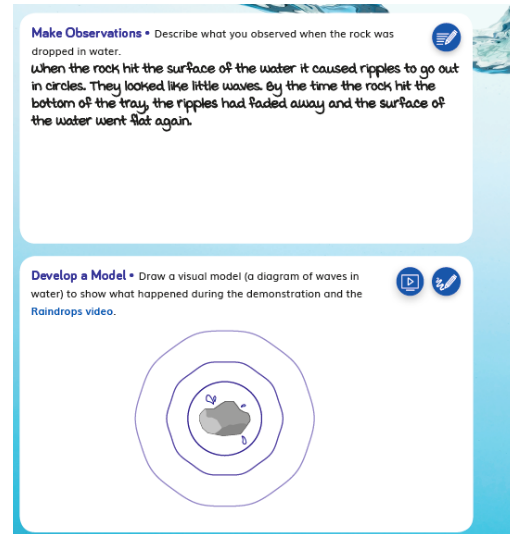

DQ1 TB pp. 5-12

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- In DQ2 (TB pp. 21-32), students explore the phenomenon of patterns in earthquake locations using an interactive map.

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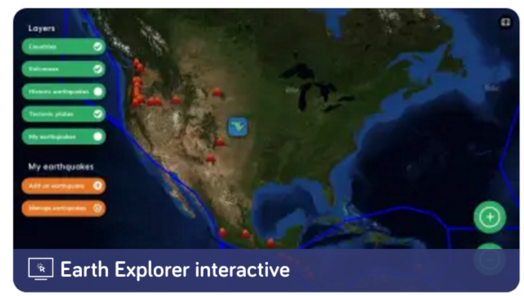

Earth Explorer Interactive

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Little Earthquake, Where Are You?

LESSON 3

Obtain Information • Using the Where On Earth Are You? video and what you discussed in class, write down definitions of the following terms.

Latitude:

The distance north or south of the equator, expressed in degrees (0–90 degrees north, 0–90 degrees south)

Longitude:

The distance east or west of the prime meridian, which runs from the North to South Pole through Greenwich in the UK, expressed in degrees (0–180 degrees west, 0–180 degrees east)

Driving Question 2 | Lesson 3 30

DQ2 TB pp. 21-32
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- In DQ2 (TB pp. 39- 46), students read and analyze the phenomena of earthquakes in Oklahoma

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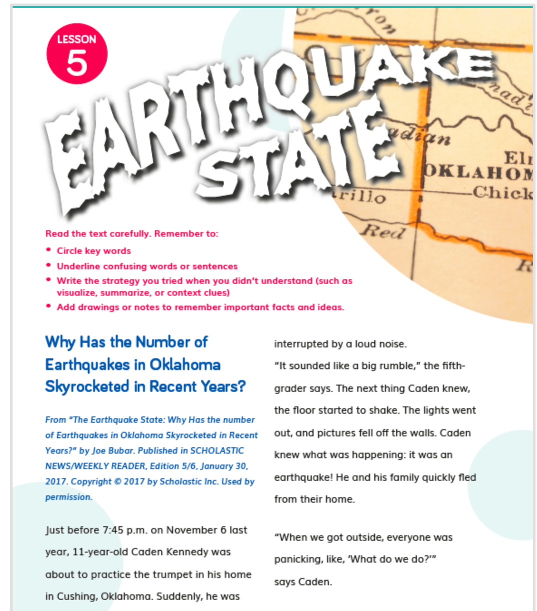
LESSON 5

EARTHQUAKE STATE

Read the text carefully. Remember to:

- Circle key words
- Underline confusing words or sentences
- Write the strategy you tried when you didn't understand (such as visualize, summarize, or context clues)
- Add drawings or notes to remember important facts and ideas.

Why Has the Number of Earthquakes in Oklahoma Skyrocketed in Recent Years?

From "The Earthquake State: Why Has the number of Earthquakes in Oklahoma Skyrocketed in Recent Years?" by Joe Bubar. Published in SCHOLASTIC NEWS/WEEKLY READER, Edition 5/6, January 30, 2017. Copyright © 2017 by Scholastic Inc. Used by permission.

Just before 7:45 p.m. on November 6 last year, 11-year-old Caden Kennedy was about to practice the trumpet in his home in Cushing, Oklahoma. Suddenly, he was interrupted by a loud noise.

"It sounded like a big rumble," the fifth-grader says. The next thing Caden knew, the floor started to shake. The lights went out, and pictures fell off the walls. Caden knew what was happening: it was an earthquake! He and his family quickly fled from their home.

"When we got outside, everyone was panicking, like, 'What do we do?'" says Caden.

DQ2 TB pp. 39- 46
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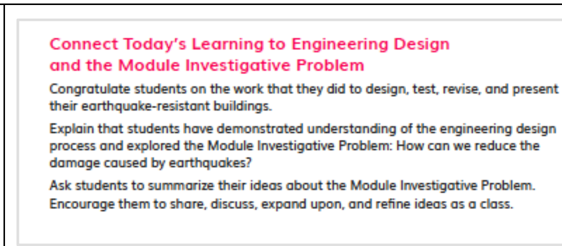
- Over DQs 3-6, students solve the problem of how to make buildings earthquake-proof by investigating different materials, real-world engineering solutions and by designing, building, testing and revising their own earthquake-proof structure.
- In DQ6L5 Connect (TE p. 205), the class summarizes their solutions to the Module Investigative Problem.


Connect Today's Learning to Engineering Design and the Module Investigative Problem

Congratulate students on the work that they did to design, test, revise, and present their earthquake-resistant buildings.

Explain that students have demonstrated understanding of the engineering design process and explored the Module Investigative Problem: How can we reduce the damage caused by earthquakes?

Ask students to summarize their ideas about the Module Investigative Problem. Encourage them to share, discuss, expand upon, and refine ideas as a class.

DQ6L5 Connect TE p. 205

SW2. Three-dimensional Conceptual Framework.
Students experiences consistently support them to use their prior knowledge to negotiate new understandings and abilities, and apply their understandings in a variety of ways.

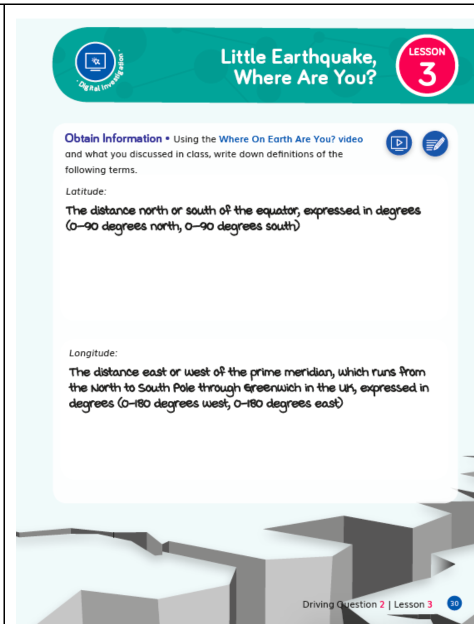
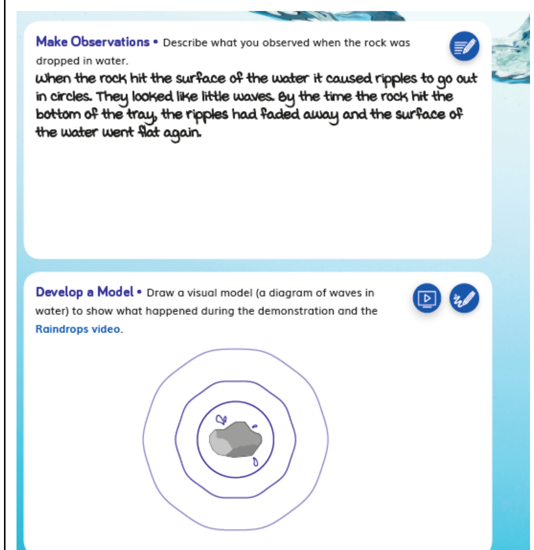
In DQ1, students start by exploring natural disasters and what causes earthquakes. They questions what they already know about these phenomena and what they still wonder about. They investigate and model the phenomenon of waves looking for patterns (CCC) in amplitude and wavelength (DCIs). They explore wave properties, how waves move objects (CCC) and use that understanding to make the connection between wave amplitude and earthquake magnitude.

Reading informational texts, they explore the phenomenon of earthquake damage and analyse data (SEP) to work out that earthquakes of a higher magnitude cause more damage. They again practice analyzing data (SEP) in an interactive map to explore patterns (CCC) in the locations of earthquakes. They ask what could be causing these patterns and figure out that earthquakes appear in bands along plate boundaries, and that earthquakes are caused when the plates move releasing waves of energy (DCI and CCC).

They start an engineering project to investigate how the shape, structure and materials of a building affects its ability to withstand forces. They apply what they learned to an engineering challenge to design, build and test their own earthquake-resistant structures. They share their designs and problems with their peers, learn from each other and brainstorm solutions (DCIs, CCC).

Next, they compare and contrast different engineering solutions used by real engineers around the world (CCC). They watch a video of what happens to a bedroom during an earthquake and are encouraged to work with their families to identity potential hazards in their own homes.

They revisit their earlier designs, applying their new knowledge to make improvements, still adhering to the criteria for success and constraints (DCIs, SEP). They wrap this final Performance Task with a presentation of their designs and have a class discussion to summarize their solutions for the problem of how to reduce earthquake damage (DCIs, SEP).

The SEPs and CCCs that the students are using in each learning activity are labeled at point of use in the student addition, called the Twig Book, in grade appropriate language (DQ3L1 TB pp. 21-22).	 DQ3L1 TB pp. 21-22
Evidence • In DQ1L2 (TB p. 5-12), students draw a model of waves and use reasoning to explain their model, building on their use of models of energy transfer in Grade 4 Modules 1 and 2.	 DQ1L2 TB p. 5-12

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- In DQ2L3 (TB p. 21-32), students argue from evidence, and explain which parts of the world are the most dangerous from earthquakes based on patterns they noticed.

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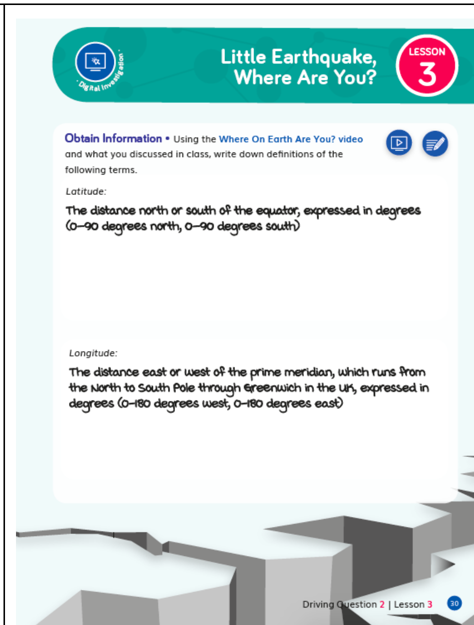

DQ3L1 TB pp. 21-22

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- In DQ6L3 (TB p. 98), students learn from their peers as they observe their tests.

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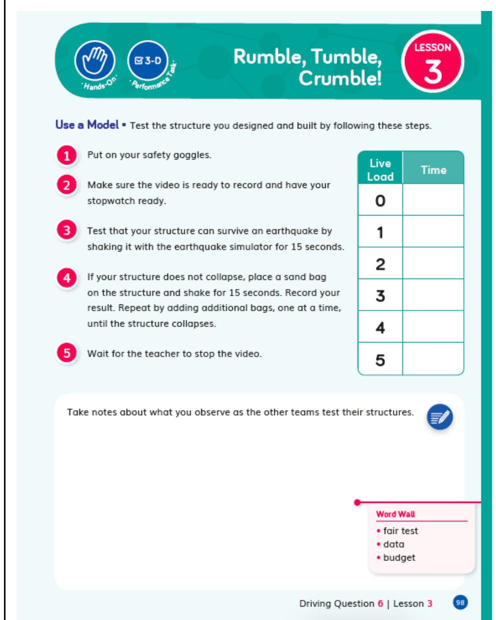

DQ6L3 TB p. 98

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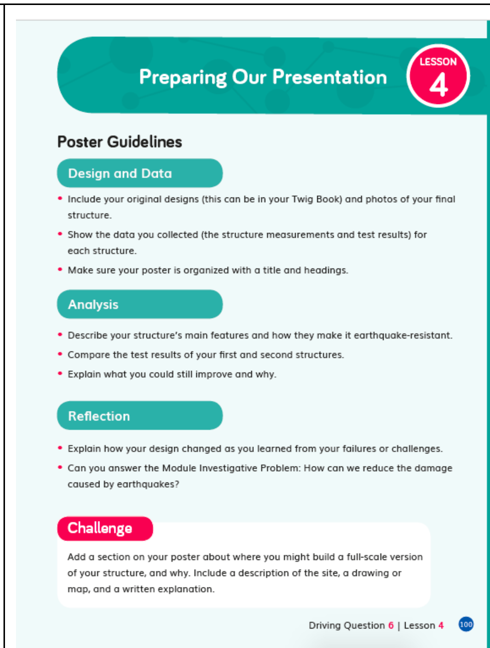
- In DQ6L4 (TB p. 100-101), students apply their new understandings and ideas to explain how their design changed as they learned from their failures and challenges.


Preparing Our Presentation

LESSON 4

Poster Guidelines

Design and Data

- Include your original designs (this can be in your Twig Book) and photos of your final structure.
- Show the data you collected (the structure measurements and test results) for each structure.
- Make sure your poster is organized with a title and headings.

Analysis

- Describe your structure's main features and how they make it earthquake-resistant.
- Compare the test results of your first and second structures.
- Explain what you could still improve and why.

Reflection

- Explain how your design changed as you learned from your failures or challenges.
- Can you answer the Module Investigative Problem: How can we reduce the damage caused by earthquakes?

Challenge

Add a section on your poster about where you might build a full-scale version of your structure, and why. Include a description of the site, a drawing or map, and a written explanation.

Driving Question 6 | Lesson 4 100

DQ6L4 TB p. 100-101

SW3. Prior Knowledge

Materials consistently leverage student prior knowledge and experiences to motivate their learning.

Across Program

Earthquake Engineering builds on prior knowledge of engineering tasks completed in previous grades—Grade K Module 2 Marble Run Engineer, Grade 2 Module 2 Master of Materials, Grade 3 Module 4 Weather Warning HQ, natural hazards—Grade K Module 3 Be Prepared, Grade 2 Module 3 Save the Island, Grade 3 Module 4 Weather Warning HQ, and use of maps—Grade 2 Module 1 My Journey West, Grade 4 Module 3 Time-Travelling Tour Guides.

Within Module

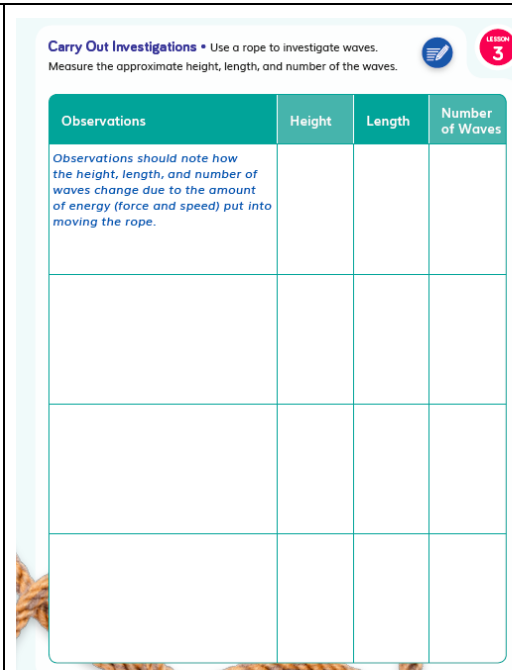
In DQ1L1, students activate their prior knowledge of natural disasters through video footage and a Prior-Knowledge Read-Aloud. They are prompted to think back to the landscape changes they explored in Grade 4 Module 3 and see how they compare to changes caused by natural disasters (CCC-5).

Throughout the module students are consistently supported to revise their claims and relate their new understandings to answering the Driving Questions and solving the Module Investigative Problem.

Throughout the module students refer to and add to their classroom Science Tools Poster, which explicitly details their growing use of the SEPs, and motivates them by helping them visualise their progression.

Evidence

- In DQ1L1 (TE p. 8), students watch footage of natural disasters and share their thinking.



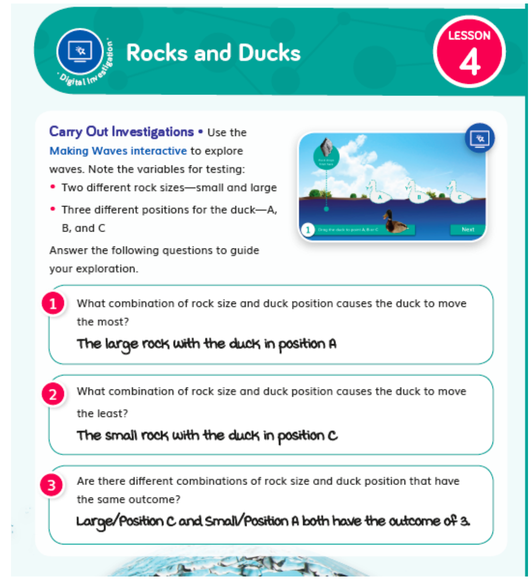
Carry Out Investigations • Use a rope to investigate waves. Measure the approximate height, length, and number of the waves.

LESSON 3

Observations	Height	Length	Number of Waves
Observations should note how the height, length, and number of waves change due to the amount of energy (force and speed) put into moving the rope.			

DQ1L1 TE p. 8

- In DQ1L1 (TE p. 10), students engage with a Prior-Knowledge Read-Aloud about earthquakes, tsunamis and volcanoes.



Rocks and Ducks

LESSON 4

Carry Out Investigations • Use the Making Waves interactive to explore waves. Note the variables for testing:

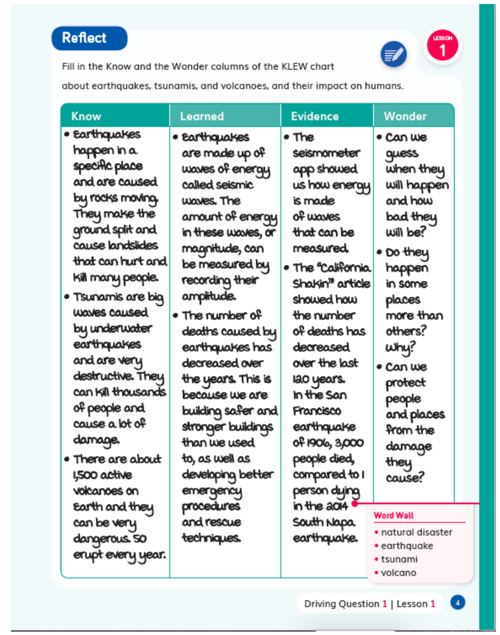
- Two different rock sizes—small and large
- Three different positions for the duck—A, B, and C

Answer the following questions to guide your exploration.

1. What combination of rock size and duck position causes the duck to move the most?
   The large rock with the duck in position A
2. What combination of rock size and duck position causes the duck to move the least?
   The small rock with the duck in position C
3. Are there different combinations of rock size and duck position that have the same outcome?
   Large/Position C and Small/Position A both have the outcome of 3.

DQ1L1 TE p. 10

- In DQ1L1 (TB p. 4), students complete a KLEW chart and note what they already know about natural disasters.



Reflect

LESSON 1

Fill in the Know and the Wonder columns of the KLEW chart about earthquakes, tsunamis, and volcanoes, and their impact on humans.

Know	Learned	Evidence	Wonder
• Earthquakes happen in a specific place and are caused by rocks moving. They make the ground split and cause landslides that can hurt and kill many people. • Tsunamis are big waves caused by underwater earthquakes and are very destructive. They can kill thousands of people and cause a lot of damage. • There are about 1,500 active volcanoes on Earth and they can be very dangerous. 50 erupt every year.	• Earthquakes are made up of waves of energy called seismic waves. The amount of energy in these waves, or magnitude, can be measured by recording their amplitude. • The number of deaths caused by earthquakes has decreased over the years. This is because we are building safer and stronger buildings than we used to, as well as developing better emergency procedures and rescue techniques.	• The seismometer app showed us how energy is made of waves that can be measured. • The "California Shakin'" article showed how the number of deaths has decreased over the last 120 years. In the San Francisco earthquake of 1906, 3,000 people died, compared to 1 person dying in the 2014 South Napa earthquake.	• Can we guess when they will happen and how bad they will be? • Do they happen in some places more than others? Why? • Can we protect people and places from the damage they cause?

Word Wall
- natural disaster
- earthquake
- tsunami
- volcano

Driving Question 1 \| Lesson 1 4

DQ1L1 TB p. 4

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- In DQ1L2 (TB p. 6), students revise their wave model and explain their thinking.

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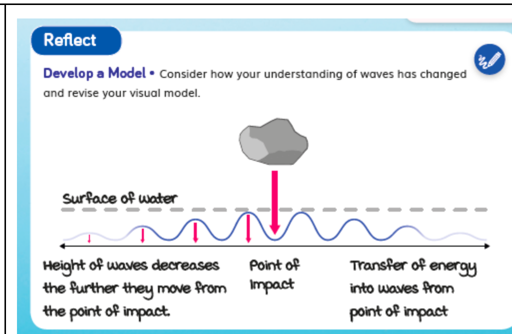

DQ1L2 TB p. 6

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- In DQ1L5 (TB p. 19), and DQ3L1 (TB p. 51), students complete a Pre-Exploration (diagnostic pre-assessment) to elicit awareness of their prior knowledge and misconceptions.

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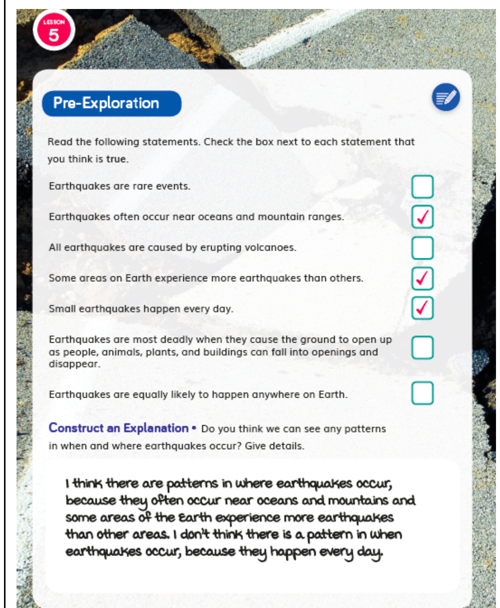

DQ1L5 TB p. 19

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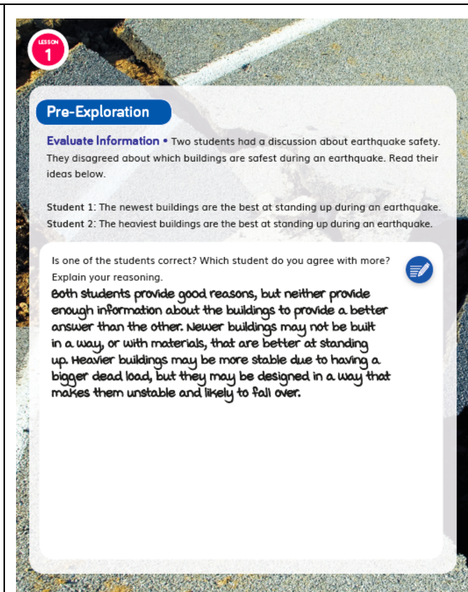

DQ3L1 TB p. 51
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- In DQ2L2 (TB p. 27), students revise their claim about what causes earthquakes following an investigation.

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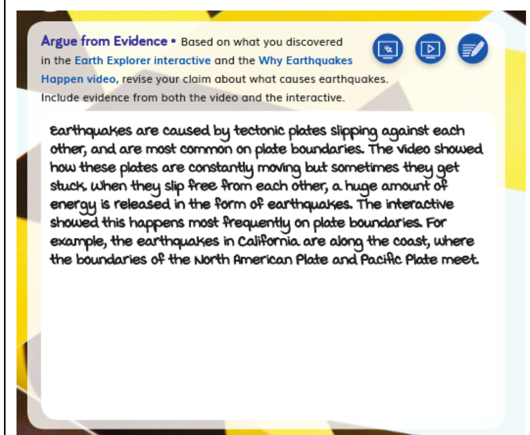

DQ2L2 TB p. 27
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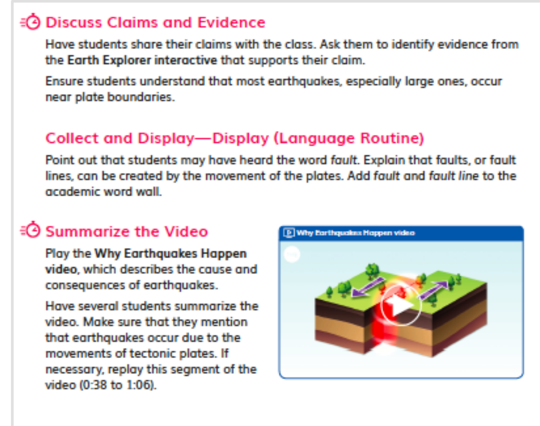
- In DQ2L3 Connect (TE p. 62), students add “Analyze data” to their Science Tools Poster.



Discuss Claims and Evidence

Have students share their claims with the class. Ask them to identify evidence from the **Earth Explorer interactive** that supports their claim.

Ensure students understand that most earthquakes, especially large ones, occur near plate boundaries.

Collect and Display—Display (Language Routine)

Point out that students may have heard the word *fault*. Explain that faults, or fault lines, can be created by the movement of the plates. Add *fault* and *fault line* to the academic word wall.

Summarize the Video

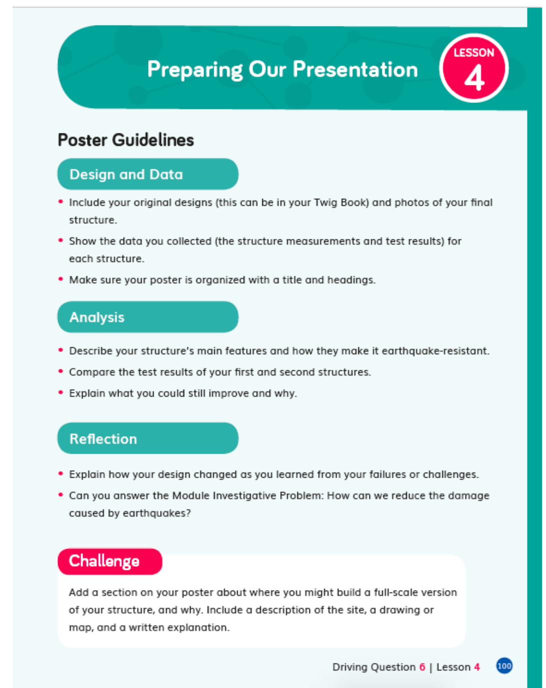
Play the **Why Earthquakes Happen video**, which describes the cause and consequences of earthquakes.

Have several students summarize the video. Make sure that they mention that earthquakes occur due to the movements of tectonic plates. If necessary, replay this segment of the video (0:38 to 1:06).

Why Earthquakes Happen video

DQ2L3 Connect TE p. 62

- In DQ6L4 (TB p. 100-101), students reflect on their new understandings and ideas about engineering solutions to reduce earthquake damage, and apply them to their building design. They also explain how their design changed as they learned from their failures and challenges.



Preparing Our Presentation

LESSON 4

Poster Guidelines

Design and Data

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Analysis

- Describe your structure's main features and how they make it earthquake-resistant.
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Reflection

- Explain how your design changed as you learned from your failures or challenges.
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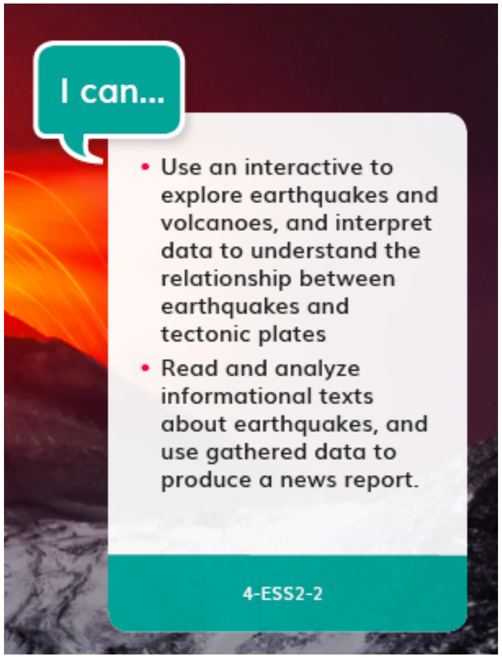
Challenge

Add a section on your poster about where you might build a full-scale version of your structure, and why. Include a description of the site, a drawing or map, and a written explanation.

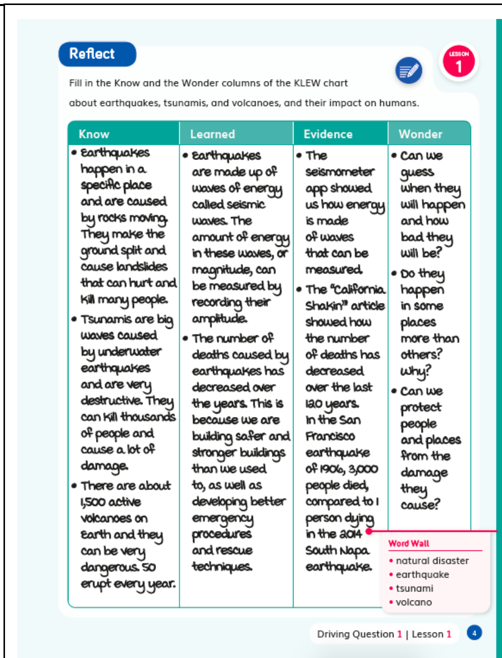
Driving Question 6 | Lesson 4 100

DQ6L4 TB p. 100-101

SW4. Metacognitive Abilities. Earthquake Engineering regularly provides students with explicit opportunities to consider how their learning experiences have changed their thinking.	
Diagnostic pre-assessments (Pre-Explorations) in DQ1L5 and DQ3L1 support students to think about the three dimensions they are already familiar with and those they are not. 'I can…' statements written in grade-appropriate language are detailed for each DQ, supporting student awareness of their growing skills and knowledge and of the three dimensions that they will use to figure out phenomenon/solve problems. See: DQ2 (TB p. 22) 'I can… use an interactive to explore earthquakes and volcanoes and interpret data to understand relationships between earthquakes and tectonic plates'.	 DQ2 TB p. 22

The five-part Twig Science lesson structure has been designed to support students to develop their metacognitive abilities on a daily basis and monitor **what** and **how** they have learned across the three dimensions.

Spark: An engaging hook activity motivates students for the investigations ahead.
Investigate: Students think like scientists and design like engineers through hands-on, digital, video and information text investigations.
Report: Students articulate what they've learned today citing evidence and their use of the three dimensions.
Connect: Students make connections to the Driving Questions and Module Investigative Problem while building knowledge of CCCs and SEPs.
Reflect: Students use different means to think about what they have learned so far and how they can use their new understandings to better figure out phenomena/problems. For example, in DQ1L1 students complete the Know and Wonder section of a Know-Learn-Evidence-Wonder (KLEW) chart to which they return later in the module to complete the Learn and Evidence sections.


Reflect

Lesson 1

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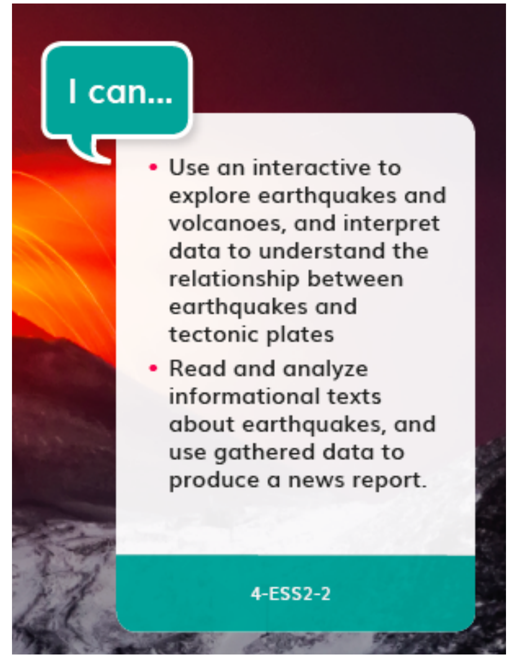
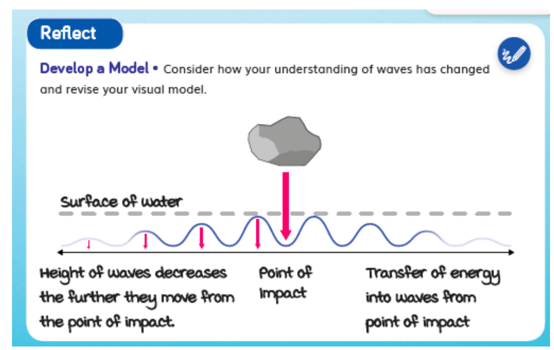
Word Wall
• natural disaster
• earthquake
• tsunami
• volcano

Driving Question 1 | Lesson 1 4

Know-Learn-Evidence-Wonder (KLEW) chart

Evidence ● In DQ2 (TB p. 22), the ‘I can…’ statement details use of the three dimensions students will use in this DQ. 'I can… use an interactive to explore earthquakes and volcanoes and interpret data to understand relationships between earthquakes and tectonic plates’.	 DQ2 TB p. 22
● In DQ1L2 (TB p. 6) and DQ1L4 (TB p. 12), students consider how their learning experiences have changed their understanding of waves.	 DQ1L2 TB p. 6

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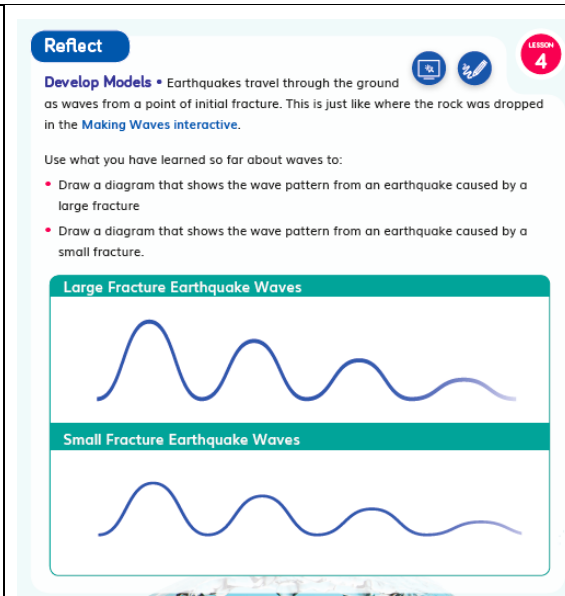

DQ1L4 TB p. 12
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- In DQ2L2 (TB p. 27), after a digital investigation students are invited to revise their claim about what causes earthquakes citing evidence.

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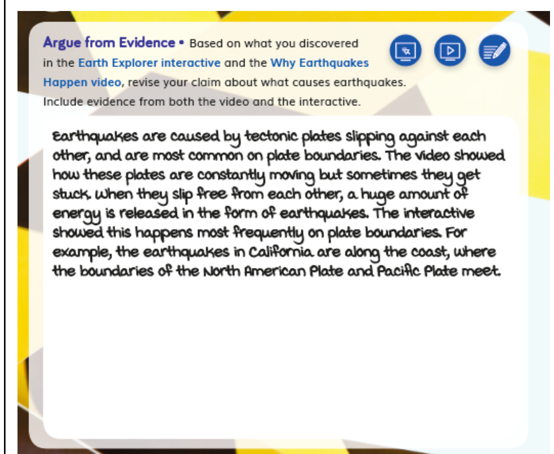

DQ2L2 TB p. 27
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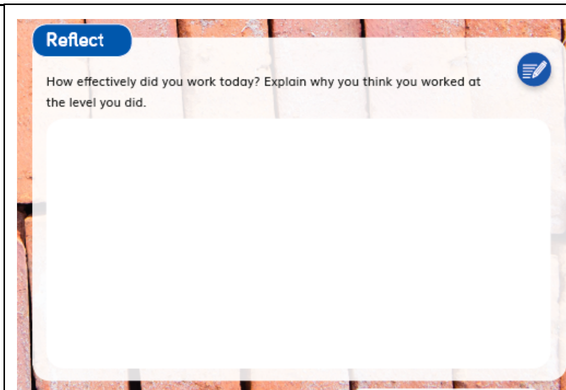
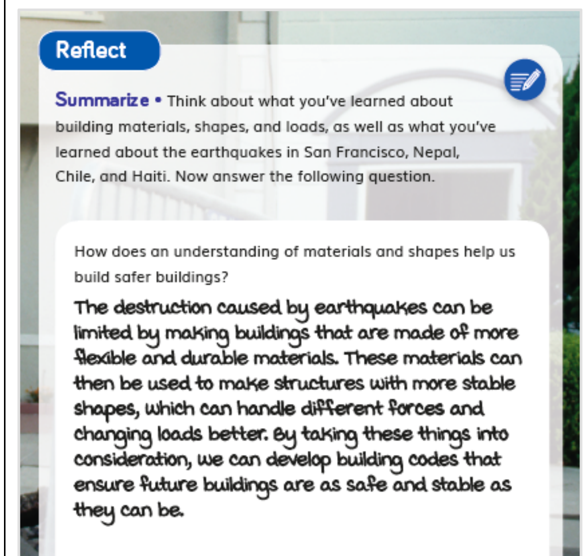
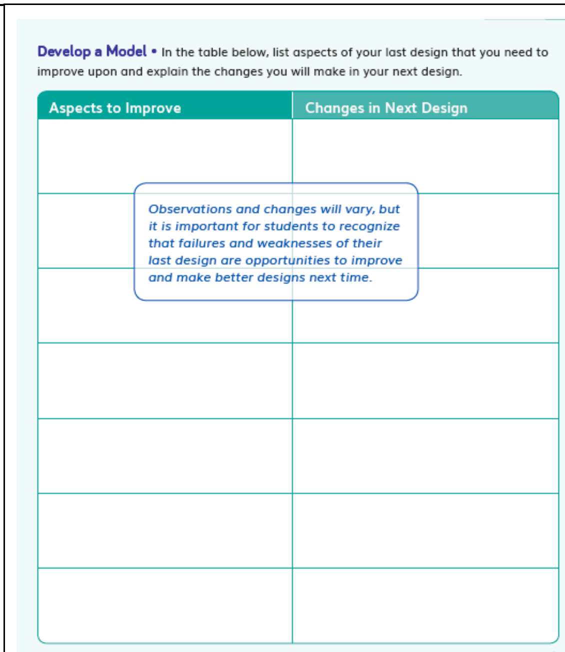
• In DQ3L3 (TB p. 58), students reflect on how effectively they worked today and why they think they worked at that level.	 DQ3L3 TB p. 58
• In DQ3L4 (TB p. 66), students evaluate information and summarize what they have learned so far about building materials.	 DQ3L4 TB p. 66

- In DQ5L4 (TB p. 90), following research tasks, students reflect what they need to change in their design and how they will do that.


Develop a Model • In the table below, list aspects of your last design that you need to improve upon and explain the changes you will make in your next design.

Aspects to Improve	Changes in Next Design

Observations and changes will vary, but it is important for students to recognize that failures and weaknesses of their last design are opportunities to improve and make better designs next time.

DQ5L4 TB p. 90

SW5. Equitable Learning Opportunities

Most learning experiences across Earthquake Engineering are multimodal in approach with numerous cross curricular connections, designed to engage students meaningfully in a variety of ways, with multiple access points, and with supports for students.

The learning experiences in the module are designed to appeal to students of all learning styles and abilities and include tasks in all domains—writing, reading, listening (read-alouds and videos), speaking (discussion and presentations), drawing, plus digital, text, video as well as hands-on investigations.

Instructional materials frequently provide support for language scaffolding for English learner students at point of use in the Teacher Editions, as well as research-based integrated language routines to support all students to “talk science” using grade-level appropriate scientific vocabulary. The digital version of the Twig Book (TB) includes a text to speech function.

Suggestions for extra access points for students with special needs are provided frequently at point of use.

Culturally relevant content is core to the module e.g. students investigate engineering solutions in California, as well as examples from around the world e.g Nepal, Japan, with additional culturally-relevant contexts, added at point of use.

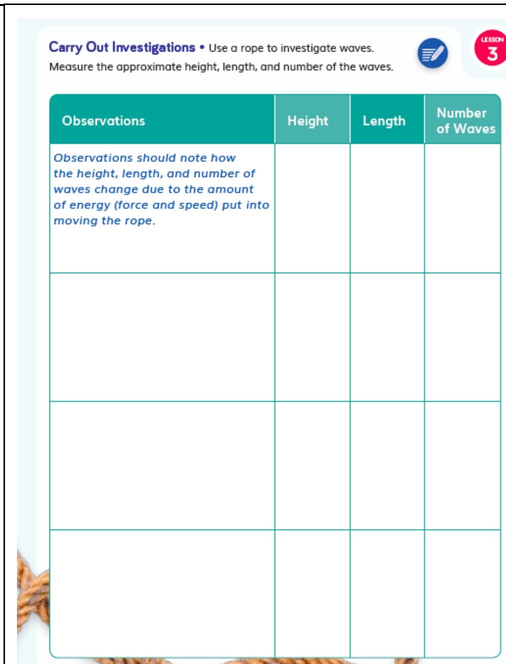
Higher Order Challenges for GATE student that have already met the learning goals are interspersed through the learning activities.

The frequent use of videos helps all students access and engage with phenomena and science concepts. Key words are overlaid as on-screen text. Students can access the ideas visually as well as via the spoken and written word. Captions are provided in both English and Spanish.

The *Shake Rattle and Roll* reader has been designed to capture the imagination of young readers with jokes and cartoons. It provides an alternative means to access the scientific content. The reader is available in four levels (Below, On, Above, EL) and Spanish, with complementary lessons to build language acquisition and develop informational text reading skills. On level lessons are in the TE, other levels available digitally. The reader features many positive role models in the field of science and engineering, designed to cultivate interest in STEM careers for all students. Chapter 2 is dedicated to an interview with a young female volcanologist. The digital version of the reader includes a text to speech function.

Evidence

- See DQ1L1 (TE p. 8), DQ1L2 (TE p. 17), DQ1L3 (TE p. 25), DQ1L4 (TE p. 30) for support for ELs.



Carry Out Investigations • Use a rope to investigate waves.
Measure the approximate height, length, and number of the waves.

LESSON 3

Observations	Height	Length	Number of Waves
Observations should note how the height, length, and number of waves change due to the amount of energy (force and speed) put into moving the rope.			

DQ1L1 TE p. 8

English Learners

Focus on students' visual models to assist them as they discuss their ideas.

Substantial Support (Emerging Proficiency)

Point to each drawing. Guide students to share information they know and questions they have in their home language. Then offer a few academic words to use as labels for each drawing. Have students repeat the words.

Moderate Support (Expanding Proficiency)

Point to each drawing. Guide students to make *I know* ____, *I think* ____, or *I learned* ____ statements about the drawing.

Light Support (Bridging Proficiency)

Point to each drawing. Have students share what they know or think using complete sentences, such as:

- *This drawing shows* ____. *I know that* ____. *This is important because* ____.

DQ1L2 TE p. 17

Discuss Observations

Have the students you selected share the results of their investigations. Encourage them to discuss their observations in terms of cause and effect.

- ***What causes a wave?***
- ***What causes the rope to move?***
- ***What are the effects of shaking the rope?***
- ***Is the effect always the same?***

Students should have discovered two measurable characteristics of waves—amplitude and wavelength. **Note:** Students will not use these terms at this point; they will be introduced during the Display portion of the Collect and Display Language Routine.

Ensure students realize that amplitude and wavelength are not connected. They can increase or decrease one without changing the other.

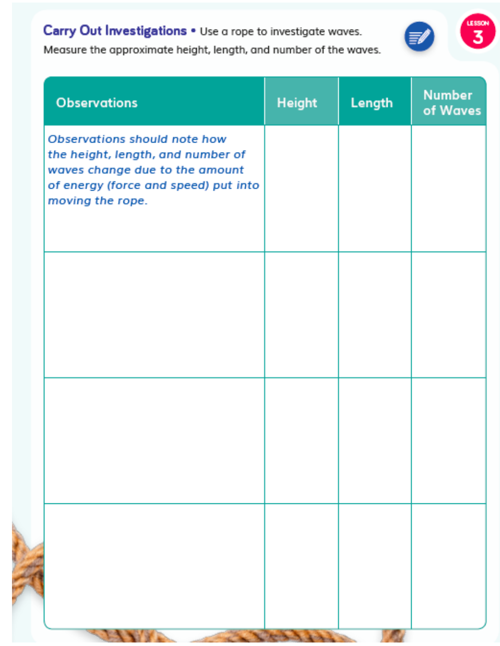
Assess students' understanding of where the energy that makes waves comes from.

- ***What is the source of the energy that creates the waves?***
- The energy comes from the hand motion.
- ***What do you need to do to put more/less energy into the rope?***
- To put more energy into the rope, you shake the rope more quickly. To put less energy into the rope, you shake the rope more slowly.
- ***What do the waves look like when more energy is transferred to the rope?***
- When more energy is transferred to the rope, the height of the waves increases.
- ***What do the waves look like when energy is transferred to the rope more quickly?***
- When energy is transferred to the rope more quickly, there are more waves.

Students may notice that the height of a wave (amplitude) decreases as it moves along the rope. Explain that the wave transfers energy along the rope and some of the energy transfers away from the wave into the surrounding air, decreasing the energy carried in the wave.

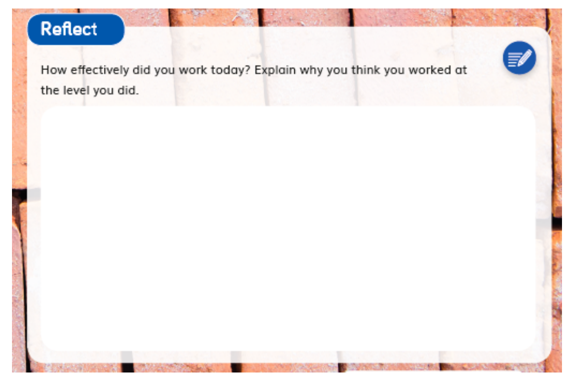
DQ1L3 TE p. 25

- See DQ1L1 (TE p. 8), DQ2L2 (TE p. 58), DQ2L3 (TE p. 67), DQ5L1 (TE p. 153) for Cultural Connections.



Observations	Height	Length	Number of Waves
Observations should note how the height, length, and number of waves change due to the amount of energy (force and speed) put into moving the rope.			

DQ1L1 TE p. 8



DQ2L2 TE p. 58

<table>
<tr>
<td></td>
<td>Cultural Connection

If there is time during the lesson, briefly share that other children around the world are also addressing earthquake safety. Let students know about Nirjan, a Nepalese boy, whose family had to rebuild their home after a major earthquake in 2015. Nirjan is no longer afraid of earthquakes because he understands how and why they happen, and knows of ways to lessen their impact.

DQ5L1 TE p. 153</td>
</tr>
<tr>
<td>See DQ1L1 (TE p. 9), DQ1L2 (TE p. 14), DQ1L3 (TE p. 23, 25) for support for students with special needs.</td>
<td>Special Needs
Fine Motor Skills
Allow students with fine motor skill challenges to dictate some of the physical actions of the build to a peer who will enact what they are saying (e.g., cutting the paper in a particular shape). However, ensure they engage with the portions of the build that they can do.

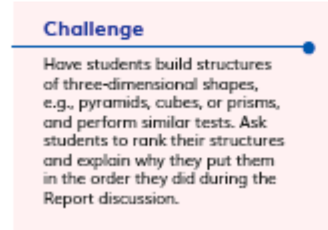
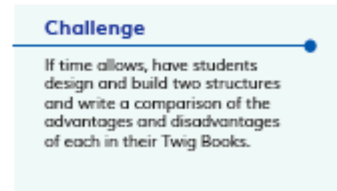
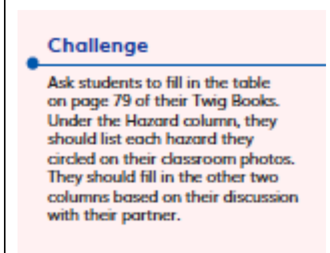
DQ1L1 TE p. 9

Special Needs
Conceptual Processing
If possible, provide access to at least one computer so that students can watch the video again at their own pace during the activity. They may wish to pause and watch sections of the video again.

DQ1L2 TE p. 14

Special Needs
Social-Emotional Functioning
If the shaking over-stimulates some students, cue them to relax and stay focused on the task using a gentle tap on the shoulder or physical proximity.

DQ1L3 TE p. 23</td>
</tr>
</table>

• See DQ3L1 GATE (TE p. 101), DQ3L3 (TE p. 113), DQ5L1 (TE p. 152) for challenges for GATE students.	 Challenge Have students build structures of three-dimensional shapes, e.g., pyramids, cubes, or prisms, and perform similar tests. Ask students to rank their structures and explain why they put them in the order they did during the Report discussion. DQ3L1 GATE TE p. 101  Challenge If time allows, have students design and build two structures and write a comparison of the advantages and disadvantages of each in their Twig Books. DQ3L3 TE p. 113  Challenge Ask students to fill in the table on page 79 of their Twig Books. Under the Hazard column, they should list each hazard they circled on their classroom photos. They should fill in the other two columns based on their discussion with their partner. DQ5L1 TE p. 152
• Films such as Building Loads (DQ3L1), LAX Engineer (DQ5L2), and Earthquakes around the World (DQ3L4) bring phenomena and concepts to life for all students.	 Building Loads (DQ3L1)

LAX Engineer (DQ5L2)

Earthquakes around the World (DQ3L4)

Designed for the NGSS: Foundations	High Quality 5	Medium Quality 3	Low Quality 1
SW1. Phenomena/Problems. Materials provide phenomena/problems that: • engage students as directly as possible in authentic and relevant experiences; • are matched to targeted learning goals; • can be figured out/solved using scientifically accurate understandings and abilities; • make connections beyond and to their daily lives including to their homes, neighborhoods, communities, and/or cultures.	Materials consistently offer quality phenomena/problems sufficient to motivate and drive student learning.	Materials sometimes offer quality phenomena/problems sufficient to motivate and drive student learning.	Materials rarely offer quality phenomena/ problems sufficient to motivate and drive student learning.
SW2. Three-dimensional Conceptual Framework. Materials include learning experiences that help students to build scientifically accurate understandings and abilities through opportunities for students to: • link prior knowledge to negotiate new understanding and abilities; • use reasoning to connect grade-appropriate SEP, DCI, and CCC elements; • ask and answer questions that link learning over time; • negotiate new understandings and abilities by comparing their ideas, their peers' ideas, and ideas encountered in the learning experiences; • apply their understandings and abilities in a variety of ways.	Materials consistently include learning experiences that help students build from prior experiences to negotiate new understandings and abilities and apply their understandings in a variety of ways.	Materials sometimes include learning experiences that help students build from prior experiences to negotiate new understandings and abilities and apply their understandings in a variety of ways.	Materials rarely include learning experiences that help students build from prior experiences to negotiate new understandings and abilities and apply their understandings in a variety of ways.
SW3. Prior Knowledge. Materials leverage students' prior knowledge and experiences to motivate student learning in ways that: • make visible students' prior knowledge and experiences related to the phenomena/problems and relevant SEPs, DCIs, and CCCs. • revisit students' early ideas to see how they have changed (or not) as they figure out phenomena/solve problems. • make explicit links to new ideas and practices being developed by students.	Materials consistently leverage student prior knowledge and experiences to motivate their learning.	Materials sometimes leverage student prior knowledge and experiences to motivate their learning.	Materials rarely leverage student prior knowledge and experiences, and when included, they do not relate to the phenomena or problems.

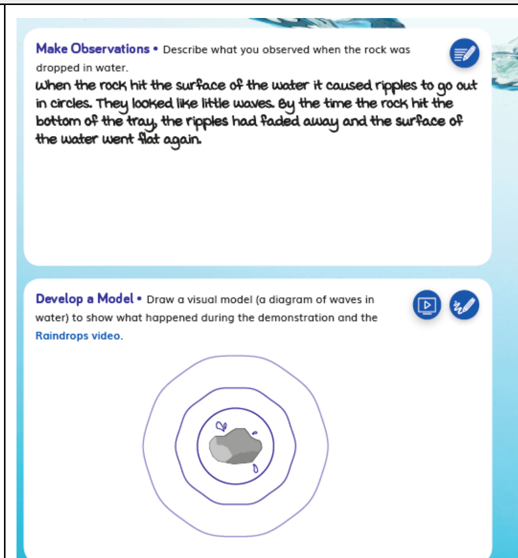
SW4. Metacognitive Abilities. Materials include learning experiences for students to: ● set and monitor their learning in light of the targeted learning goals; ● consider, over time, **what** and **how** they have learned across the three dimensions; ● articulate how the three dimensions helped them figure out phenomena/solve problems.	The materials provide students with regular, explicit opportunities to consider how their learning experiences changed their thinking.	The materials provide students with some opportunities to consider how their learning experiences changed their thinking.	The materials provide few opportunities for students to consider how their learning experiences changed their thinking.
SW5. Equitable Learning Opportunities: Materials ensure that ***all*** students, including those from non-dominant groups and with diverse learning needs, have access to the targeted learning goals and experiences, including: ● appropriate reading, writing, listening, and/or speaking alternatives for students who are English language learners, have special needs, read below the grade level, or have high interest and have already met the intended learning goals. ● culturally-relevant contexts and examples that support all students. ● opportunities to cultivate interest and confidence as scientists and engineers for all students.	Most learning experiences in materials are designed such that students can engage meaningfully in a variety of ways, with multiple access points, and with supports for students.	Some learning experiences in materials are designed such that students can engage meaningfully in a variety of ways, with multiple access points, and with supports for students.	Few learning experiences in materials are designed such that students can engage meaningfully in a variety of ways, with multiple access points, and with supports for students.

Designed for NGSS: Student Work

Analyze Evidence

Directions:

1. Review the Designed for NGSS: Foundations Rubric.
2. Reflect on the evidence (or lack of evidence) that you and your team gathered and represented.
3. Record strengths and limitations for each criterion based on your evidence. Cite specific examples.

Strengths	
SW 1: Phenomena/ Problems	
The Student Work is High Quality (5) in terms of SW1 Materials consistently offer quality phenomena/ problems sufficient to motivate and drive student learning.	
Evidence • In DQ1L2-4 (TB pp. 5-12), students investigate into the phenomenon of wave amplitude and wavelength using water, ropes, and an interactive.	 DQ1 L2-4 TB pp. 5-12

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- In DQ2L1-3 (TB pp. 21-32), students explore the phenomenon of patterns in earthquake locations using an interactive map.

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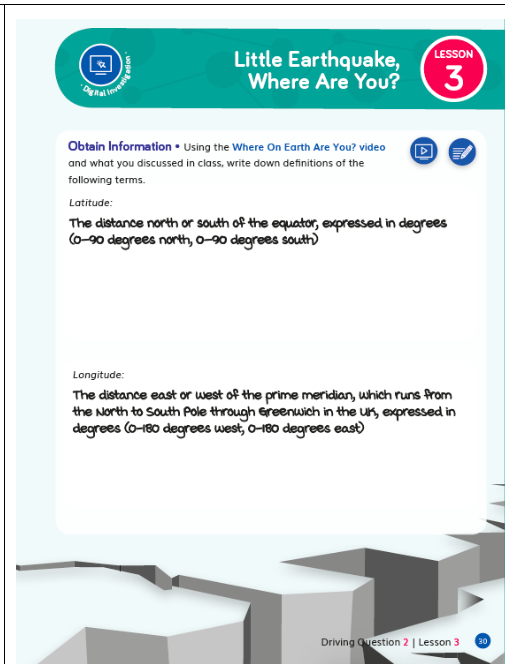

DQ2 L1-3 TB pp. 21-32

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- In DQ2L5 (TB p. 39- 46), students read and analyze the phenomena of earthquakes in Oklahoma.
- Over DQs 3-6, students solve the problem of how to make buildings earthquake-proof by investigating different materials, real-world engineering solutions and by designing, building, testing and revising their own earthquake-proof structure.

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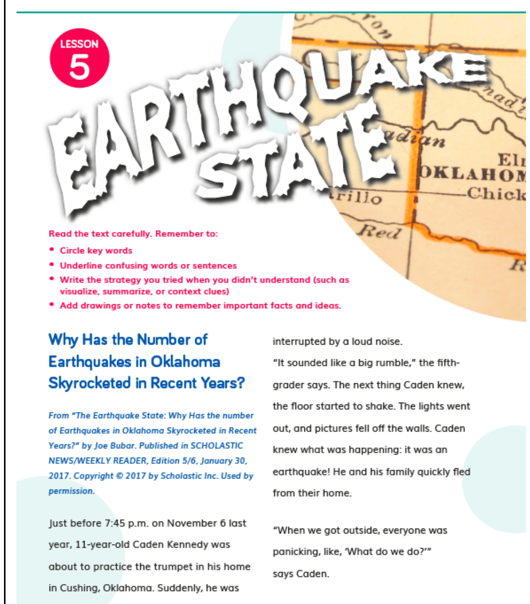

DQ2L5 TB p. 39- 46

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- In DQ6L5 Connect (TE p. 205), the class summarizes their solutions to the Module Investigative Problem.

Connect Today's Learning to Engineering Design and the Module Investigative Problem

Congratulate students on the work that they did to design, test, revise, and present their earthquake-resistant buildings.

Explain that students have demonstrated understanding of the engineering design process and explored the Module Investigative Problem: How can we reduce the damage caused by earthquakes?

Ask students to summarize their ideas about the Module Investigative Problem. Encourage them to share, discuss, expand upon, and refine ideas as a class.

DQ6L5 Connect TE p. 205

SW 2: Three-Dimensional Conceptual Framework

The Student Work is High Quality (5) in terms of SW2

Materials consistently include learning experiences that help students build from prior experiences to negotiate new understandings and abilities and apply their understandings in a variety of ways.

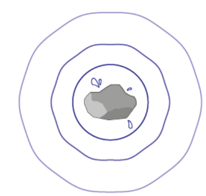
Evidence

- In DQ1L1 TB pp. 5-6, after an investigation, students draw a model of waves and use reasoning to explain their model, building on their use of models of energy transfer in Grade 4 Modules 1 and 2. Students go on to revise their model and explain their thinking.

Make Observations • Describe what you observed when the rock was dropped in water.

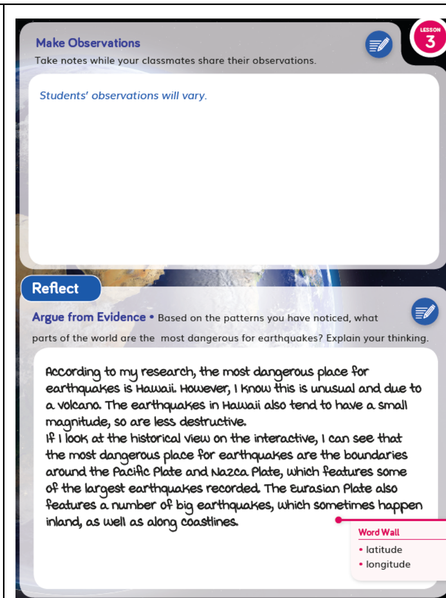
When the rock hit the surface of the water it caused ripples to go out in circles. They looked like little waves. By the time the rock hit the bottom of the tray, the ripples had faded away and the surface of the water went flat again.

Develop a Model • Draw a visual model (a diagram of waves in water) to show what happened during the demonstration and the Raindrops video.



DQ1L1 TB pp. 5

- In DQ2L3 TB p. 32, students argue from evidence, and explain which parts of the world are the most dangerous from earthquakes based on patterns they noticed.


LESSON 3

Make Observations

Take notes while your classmates share their observations.

Students' observations will vary.

Reflect

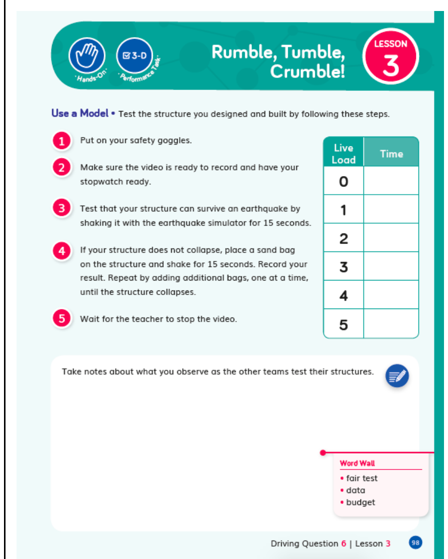
Argue from Evidence • Based on the patterns you have noticed, what parts of the world are the most dangerous for earthquakes? Explain your thinking.

According to my research, the most dangerous place for earthquakes is Hawaii. However, I know this is unusual and due to a volcano. The earthquakes in Hawaii also tend to have a small magnitude, so are less destructive.
If I look at the historical view on the interactive, I can see that the most dangerous place for earthquakes are the boundaries around the Pacific Plate and Nazca Plate, which features some of the largest earthquakes recorded. The Eurasian Plate also features a number of big earthquakes, which sometimes happen inland, as well as along coastlines.

Word Wall
- latitude
- longitude

DQ2L3 TB p. 32

- In DQ6L3 TB p. 98, students learn from their peers as they observe their tests.


Hands-On · 3-D Performance Task

Rumble, Tumble, Crumble!

LESSON 3

Use a Model • Test the structure you designed and built by following these steps.

1. Put on your safety goggles.
2. Make sure the video is ready to record and have your stopwatch ready.
3. Test that your structure can survive an earthquake by shaking it with the earthquake simulator for 15 seconds.
4. If your structure does not collapse, place a sand bag on the structure and shake for 15 seconds. Record your result. Repeat by adding additional bags, one at a time, until the structure collapses.
5. Wait for the teacher to stop the video.

Live Load	Time
0	
1	
2	
3	
4	
5	

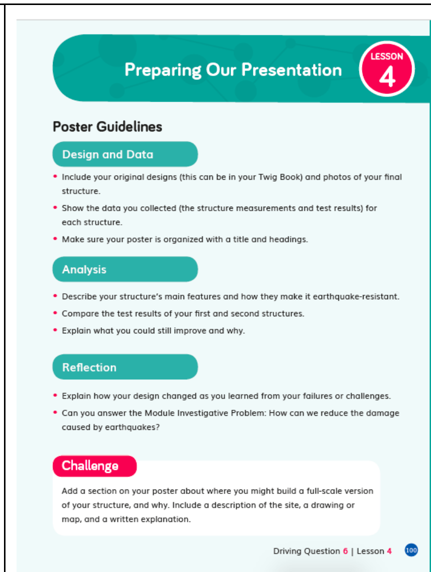
Take notes about what you observe as the other teams test their structures.

Word Wall
- fair test
- data
- budget

Driving Question 6 | Lesson 3 98

DQ6L3 TB p. 98

- In DQ6L4 TB p. 100, students apply their new understandings and ideas, and explain how their design changed as they learned from their failures and challenges.


Preparing Our Presentation

LESSON 4

Poster Guidelines

Design and Data

- Include your original designs (this can be in your Twig Book) and photos of your final structure.
- Show the data you collected (the structure measurements and test results) for each structure.
- Make sure your poster is organized with a title and headings.

Analysis

- Describe your structure's main features and how they make it earthquake-resistant.
- Compare the test results of your first and second structures.
- Explain what you could still improve and why.

Reflection

- Explain how your design changed as you learned from your failures or challenges.
- Can you answer the Module Investigative Problem: How can we reduce the damage caused by earthquakes?

Challenge

Add a section on your poster about where you might build a full-scale version of your structure, and why. Include a description of the site, a drawing or map, and a written explanation.

Driving Question 6 | Lesson 4 100

DQ6L4 TB p. 100

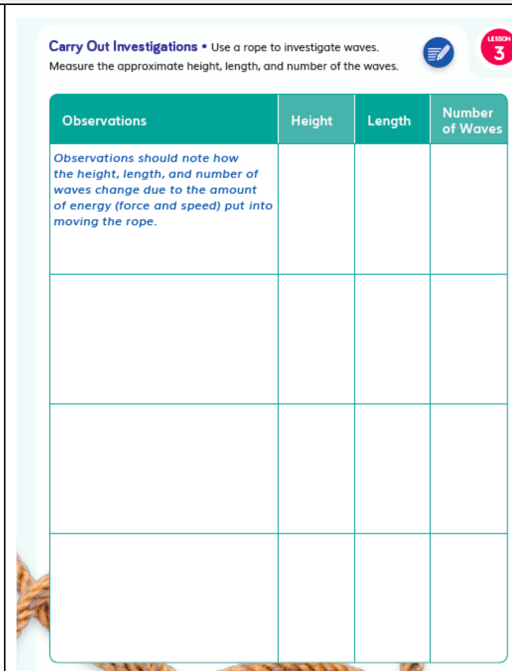
SW 3: Prior Knowledge

The Student Work is High Quality (5) in terms of SW3

Materials consistently leverage student prior knowledge and experiences to motivate their learning.

Evidence

- In DQ1L1 TE p. 8, students watch footage of natural disasters and share their thinking.



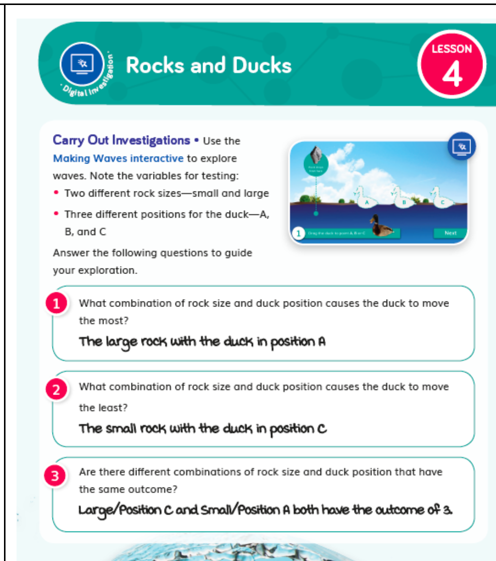
Carry Out Investigations • Use a rope to investigate waves. Measure the approximate height, length, and number of the waves.

LESSON 3

Observations	Height	Length	Number of Waves
Observations should note how the height, length, and number of waves change due to the amount of energy (force and speed) put into moving the rope.			

DQ1L1 TE p. 8

- In DQ1L1 TE p. 10, students engage with a Prior-Knowledge Read-Aloud about earthquakes, tsunamis and volcanoes.

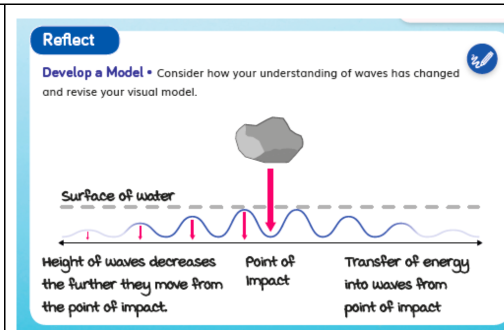


DQ1L1 TE p. 10

- In DQ1L1 TB p. 4, students complete a KLEW chart and note what they already know about natural disasters.

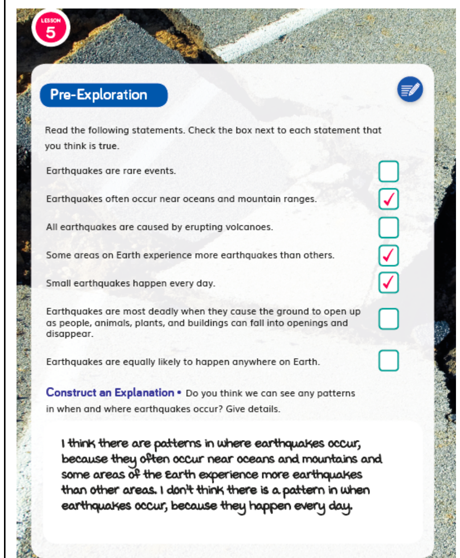
DQ1L1 TB p. 4

- In DQ1L2 TB p. 6, students revise their wave model and explain their thinking.



DQ1L2 TB p. 6

- In D1L5 TB p. 19, and DQ3L1 TB p. 51, students complete a Pre-Exploration (diagnostic pre-assessment) to elicit awareness of their prior knowledge and misconceptions.



D1L5 TB p. 19

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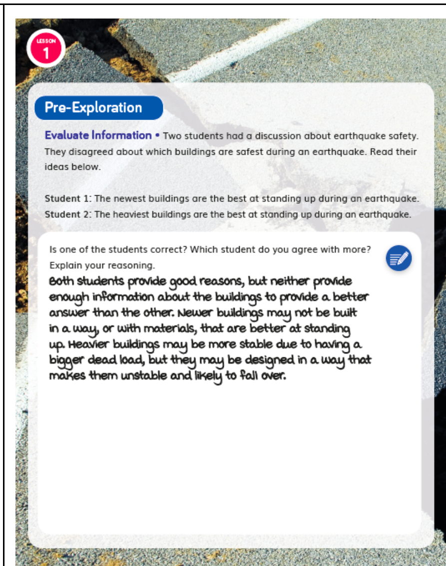
<td>

DQ3L1 TB p. 51</td>
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- In DQ2L2 TB p. 27, students revise their claim about what causes earthquakes following an investigation.

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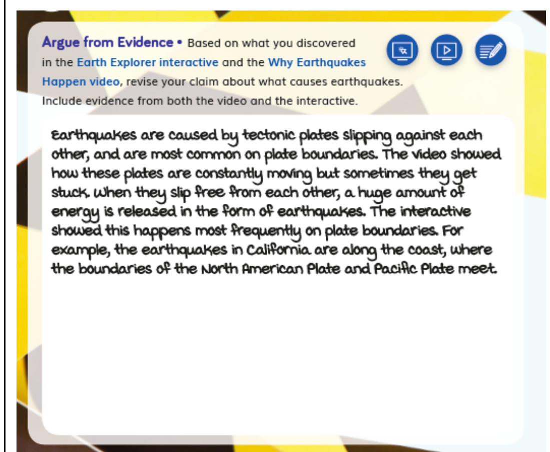
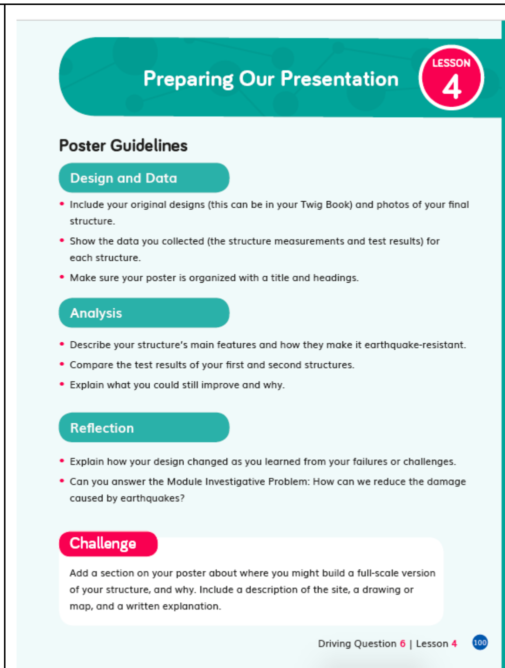
<td>

DQ2L2 TB p. 27</td>
</tr>
<tr>
<td colspan="2">In DQ2L3 Connect TE p. 60, students add “Analyze data” to their Science Tools Poster.</td>
</tr>
</table>

- In DQ6L4 TB p. 100, students reflect on their new understandings and ideas about engineering solutions to reduce earthquake damage, apply them to their building design, and explain how their design changed as they learned from their failures and challenges.



DQ6L4 TB p. 100

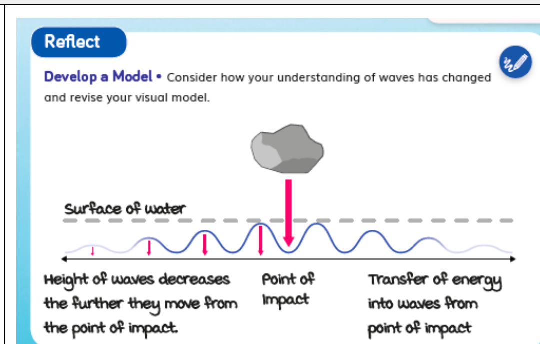
SW 4: Metacognitive Abilities

The Student Work is High Quality (5) in terms of SW4

The materials provide students with regular, explicit opportunities to consider how their learning experiences changed their thinking.

Evidence

- In DQ1L2 TB p. 6 and DQ1L4 p. 12, students consider how their learning experiences have changed their understanding of waves.



DQ1L2 TB p. 6

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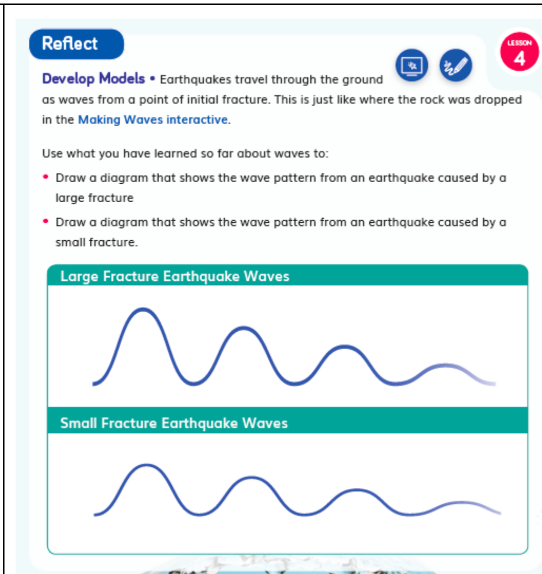

DQ1L4 p. 12
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- In DQ2L2 TB p. 27, after a digital investigation, students are invited to revise their claim about what causes earthquakes citing evidence.

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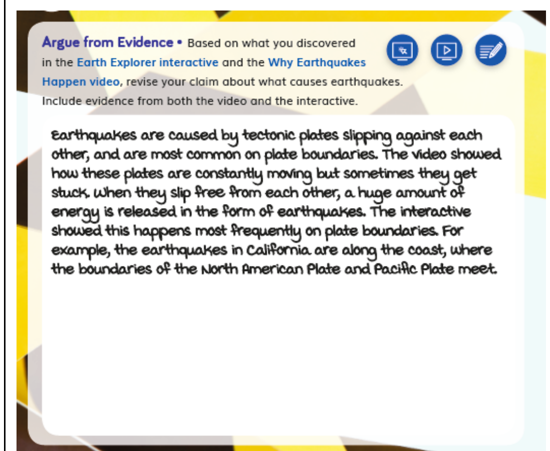

DQ2L2 TB p. 27
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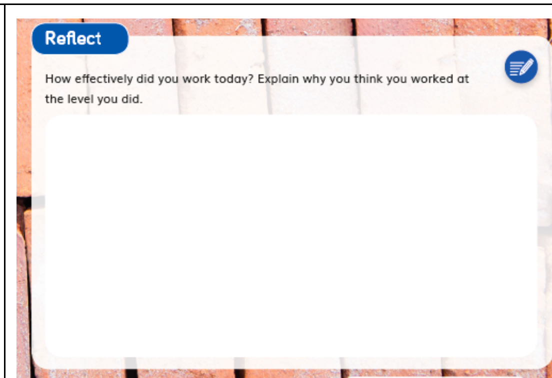
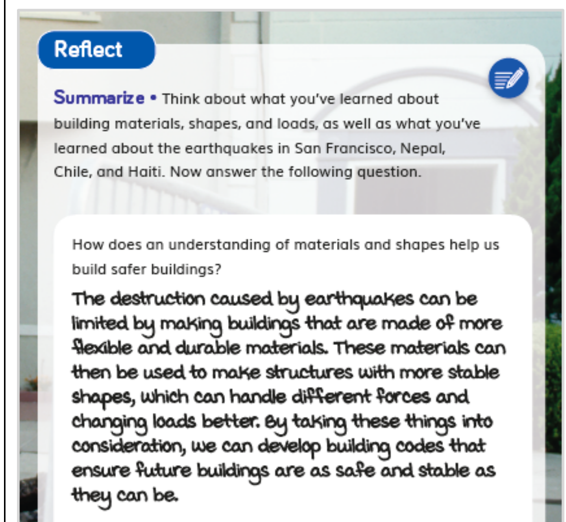
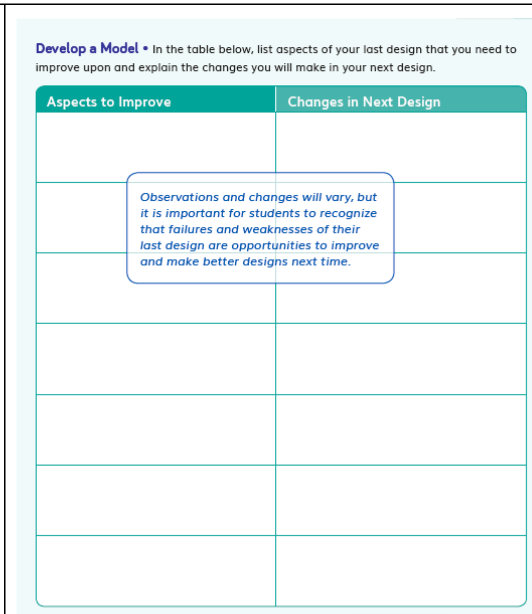
• In DQ3L3 TB p. 58, students reflect on how effectively they worked today and why they think they worked at that level.	 DQ3L3 TB p. 58
• In DQ3L4 TB p. 66, students evaluate information and summarize what they have learned so far about building materials.	 DQ3L4 TB p. 66

- in DQ5L4TB p. 90, following research tasks, students reflect what they need to change in their design and how they will make those changes.

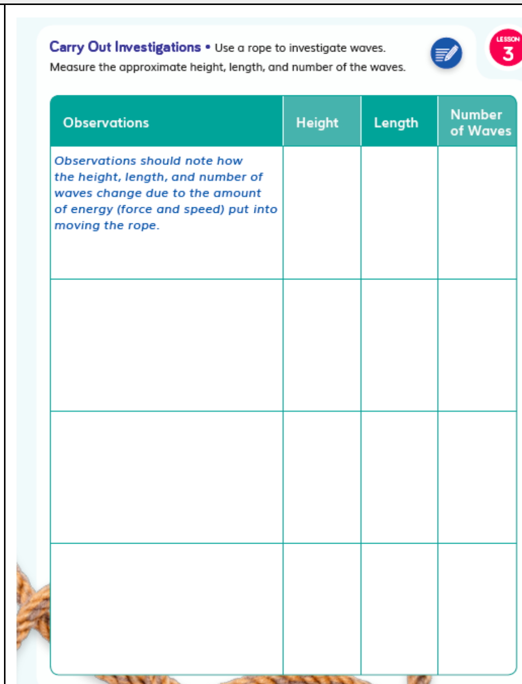


Develop a Model • In the table below, list aspects of your last design that you need to improve upon and explain the changes you will make in your next design.

Aspects to Improve	Changes in Next Design

Observations and changes will vary, but it is important for students to recognize that failures and weaknesses of their last design are opportunities to improve and make better designs next time.

DQ5L4TB p. 90

SW 5: Equitable Learning Opportunities	
The Student Work is High Quality (5) in terms of SW5 Most learning experiences in materials are designed such that students can engage meaningfully in a variety of ways, with multiple access points, and with supports for students.	
Evidence • See TE DQ1L1 p. 8. 10, DQ1L2 p. 17, DQ1L3 p. 25, DQ1L4 p. 30 for support for ELs.	 TE DQ1L1 p. 8

English Learners

Focus on students' visual models to assist them as they discuss their ideas.

Substantial Support (Emerging Proficiency)

Point to each drawing. Guide students to share information they know and questions they have in their home language. Then offer a few academic words to use as labels for each drawing. Have students repeat the words.

Moderate Support (Expanding Proficiency)

Point to each drawing. Guide students to make *I know ____*, *I think ____*, or *I learned ____* statements about the drawing.

Light Support (Bridging Proficiency)

Point to each drawing. Have students share what they know or think using complete sentences, such as:

- *This drawing shows ____. I know that ____. This is important because ____.*

DQ1L2 p. 17

Discuss Observations

Have the students you selected share the results of their investigations. Encourage them to discuss their observations in terms of cause and effect.

- ***What causes a wave?***
- ***What causes the rope to move?***
- ***What are the effects of shaking the rope?***
- ***Is the effect always the same?***

Students should have discovered two measurable characteristics of waves—amplitude and wavelength. **Note:** Students will not use these terms at this point; they will be introduced during the Display portion of the Collect and Display Language Routine.

Ensure students realize that amplitude and wavelength are not connected. They can increase or decrease one without changing the other.

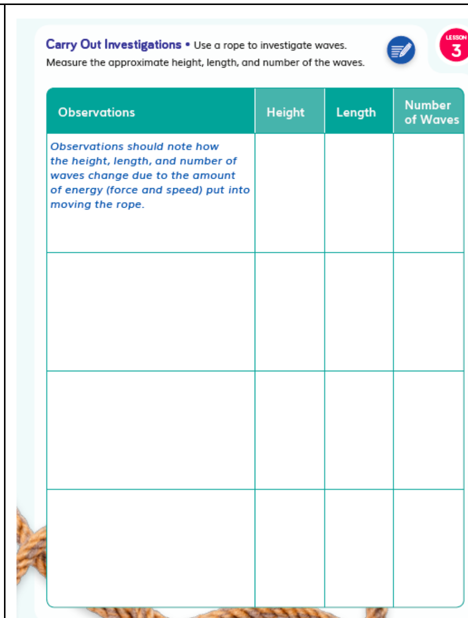
Assess students' understanding of where the energy that makes waves comes from.

- ***What is the source of the energy that creates the waves?***
- The energy comes from the hand motion.
- ***What do you need to do to put more/less energy into the rope?***
- To put more energy into the rope, you shake the rope more quickly. To put less energy into the rope, you shake the rope more slowly.
- ***What do the waves look like when more energy is transferred to the rope?***
- When more energy is transferred to the rope, the height of the waves increases.
- ***What do the waves look like when energy is transferred to the rope more quickly?***
- When energy is transferred to the rope more quickly, there are more waves.

Students may notice that the height of a wave (amplitude) decreases as it moves along the rope. Explain that the wave transfers energy along the rope and some of the energy transfers away from the wave into the surrounding air, decreasing the energy carried in the wave.

DQ1L3 p. 25

- See TE DQ1L1 p. 8, DQ2L2 p. 58, DQ2L3 p. 67, DQ5L1 p. 153 for Cultural Connections.

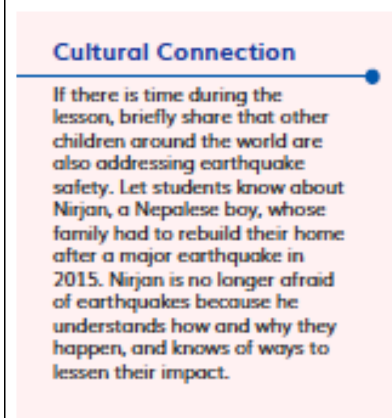


Carry Out Investigations • Use a rope to investigate waves. Measure the approximate height, length, and number of the waves.

LESSON 3

Observations	Height	Length	Number of Waves
Observations should note how the height, length, and number of waves change due to the amount of energy (force and speed) put into moving the rope.			

TE DQ1L1 p. 8



Cultural Connection

If there is time during the lesson, briefly share that other children around the world are also addressing earthquake safety. Let students know about Nirjan, a Nepalese boy, whose family had to rebuild their home after a major earthquake in 2015. Nirjan is no longer afraid of earthquakes because he understands how and why they happen, and knows of ways to lessen their impact.

DQ5L1 p. 153

• See TE DQ1L1 p. 9, DQ1L2 p. 14, DQ1L3 p. 23, 25 for support for students with special needs.	**Special Needs** **Fine Motor Skills** Allow students with fine motor skill challenges to dictate some of the physical actions of the build to a peer who will enact what they are saying (e.g., cutting the paper in a particular shape). However, ensure they engage with the portions of the build that they can do. TE DQ1L1 p. 9 **Special Needs** **Conceptual Processing** If possible, provide access to at least one computer so that students can watch the video again at their own pace during the activity. They may wish to pause and watch sections of the video again. DQ1L2 p. 14 **Special Needs** **Social-Emotional Functioning** If the shaking over-stimulates some students, cue them to relax and stay focused on the task using a gentle tap on the shoulder or physical proximity. DQ1L3 p. 23
• See TE DQ1L1 p. 9, DQ3L1 p. 101, DQ3L3 p. 113, DQ5L1 p. 152 for challenges for GATE students .	**Special Needs** **Fine Motor Skills** Allow students with fine motor skill challenges to dictate some of the physical actions of the build to a peer who will enact what they are saying (e.g., cutting the paper in a particular shape). However, ensure they engage with the portions of the build that they can do. TE DQ1L1 p. 9

	Challenge Have students build structures of three-dimensional shapes, e.g., pyramids, cubes, or prisms, and perform similar tests. Ask students to rank their structures and explain why they put them in the order they did during the Report discussion. DQ3L1 p. 101 **Challenge** Ask students to fill in the table on page 79 of their Twig Books. Under the Hazard column, they should list each hazard they circled on their classroom photos. They should fill in the other two columns based on their discussion with their partner. DQ5L1 p. 152
• Films such as Building Loads (DQ3L1), LAX Engineer (DQ5L2), and Earthquakes around the World (DQ3L4) bring phenomena and concepts to life for all students.	 Building Loads (DQ3L1)  LAX Engineer (DQ5L2)

Earthquakes around the World (DQ3L4)