Lesson 1: What is causing Mt. Everest and other mountains to move, grow, or shrink?

<table>
<thead>
<tr>
<th>Previous Lesson</th>
<th>There is no previous lesson.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This Lesson</td>
<td>We read about how Mt. Everest is getting taller and moving to the northeast over time. We look at data of four other mountains and find out that they are also changing in elevation, with some shrinking. We model, at a scale larger than we can see, what we think causes a mountain to change in elevation. We brainstorm related phenomena where land near us has changed over time. This leads us to a broad set of questions that we use to form our Driving Question Board (DQB). We brainstorm possible investigations we could do and additional data sources that could help answer our questions.</td>
</tr>
<tr>
<td>Anchoring Phenomenon</td>
<td>4 days</td>
</tr>
<tr>
<td>Next Lesson</td>
<td>We will look at data sources from Ridgecrest, CA before and after an earthquake and determine that there may be a correlation between earthquakes and mountain growth. We will use Seismic Explorer to investigate the depths and magnitudes of earthquakes at our case sites.</td>
</tr>
</tbody>
</table>

BUILDING TOWARD NGSS

<table>
<thead>
<tr>
<th>MS-ESS1-4, MS-ESS2-1, MS-ESS2-2, MS-ESS2-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>What students will do</td>
</tr>
<tr>
<td>1.A Develop a model showing what is happening at a scale larger than we can see (patterns) to help explain what happened to the different mountains to (cause) them to change (in elevation and/or location).</td>
</tr>
<tr>
<td>1.B Ask questions that arise from our analysis of information showing that Mt. Everest and four other mountain peaks are changing to seek additional information about what caused the changes (effects) we read about.</td>
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</tbody>
</table>

What students will figure out

- Some mountains move.
- Mountains can get taller.
- Mt. Everest is growing over time.
- Mountains can also shrink.
<table>
<thead>
<tr>
<th>Part</th>
<th>Duration</th>
<th>Summary</th>
<th>Slide</th>
<th>Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4 min</td>
<td>EXPLORE AN INTERESTING PHENOMENA&lt;br&gt;We are introduced to a headline claiming that Mt. Everest is growing. We find where Mt. Everest is located on the world map.</td>
<td>A-B</td>
<td>1 Earth squish ball globe with countries labeled, 1 Earth squish ball globe with no labels, 2 paper coffee sleeves, World Map (large wall global relief map), Inflated 12” inflatable globe, 2 sticky notes (or this can be a regular sticky note cut in half)</td>
</tr>
<tr>
<td>2</td>
<td>10 min</td>
<td>READ ABOUT MT. EVEREST&lt;br&gt;Students read about how Mt. Everest is changing based on data collected by Nepal and China.</td>
<td>C-D</td>
<td>What is happening on Mount Everest?</td>
</tr>
<tr>
<td>3</td>
<td>6 min</td>
<td>RECORD WHAT IS HAPPENING AT MT. EVEREST&lt;br&gt;Students share what they read about what is happening at Mt. Everest and how this was recorded.</td>
<td>E</td>
<td>What is happening on Mount Everest?, Mt Everest Notice and Wonder poster</td>
</tr>
<tr>
<td>4</td>
<td>7 min</td>
<td>DEVELOP INITIAL MODEL&lt;br&gt;Students develop an initial model to represent what they think is causing Mt. Everest to move and increase in elevation over time.</td>
<td>F-G</td>
<td>Explain How Mt. Everest Moves And Grows, Alternate: Initial Model</td>
</tr>
<tr>
<td>5</td>
<td>3 min</td>
<td>REVISIT CLASSROOM NORMS&lt;br&gt;Have students review the classroom norms and set expectations for their work together on a consensus model. Prompt students to pick one norm to focus on for today.</td>
<td>H</td>
<td>What is happening on Mount Everest?, Explain How Mt. Everest Moves And Grows, chart paper, markers, Discussion Norms poster</td>
</tr>
<tr>
<td>6</td>
<td>15 min</td>
<td>DEVELOP A CLASSROOM CONSENSUS MODEL&lt;br&gt;The class develops a consensus model to represent what is happening at Mt. Everest and what is causing these changes.</td>
<td>I</td>
<td>Explain How Mt. Everest Moves And Grows or Alternate: Initial Model, What Is Causing Everest to Move and Grow initial model poster, markers, Discussion Norms poster</td>
</tr>
<tr>
<td>7</td>
<td>5 min</td>
<td>NAVIGATION&lt;br&gt;Students share where else mountains can be found on Earth. Then they consider what data from these mountains we would want to look for, to help us figure out what is happening at Everest.</td>
<td>J</td>
<td></td>
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</tbody>
</table>

End of day 1
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
</table>
| 8    | COMPARE DIFFERENT MOUNTAIN PEAK INFORMATION CARDS  
Students analyze 5 different mountain cases in a jigsaw to look for similar data at other mountains about movement or growth. |
| 9    | COMPARE MOUNTAIN SITE LOCATIONS  
Students share with their small group the data they found for their assigned mountain about changes in elevation and lateral movement. |
| 10   | SHARE PATTERNS IN GROWTH AND MOVEMENT BETWEEN DIFFERENT MOUNTAINS  
Students share with the class patterns they found that were similar for the different mountains that might also explain how a mountain could move and/or grow. |
| 11   | DEVELOP INITIAL MODEL OF SHRINKING MOUNTAIN  
Students will develop a model to represent what causes a mountain to shrink. |
| 12   | ADD TO THE CLASSROOM CONSENSUS MODEL  
The class develops a consensus model to represent mountains that are shrinking. |
| 13   | BRAINSTORM RELATED PHENOMENA  
Students think about the land and landforms in the area they live where they have seen changes and brainstorm whether the causes of these changes could be similar to what is causing Mt. Everest to change. |
| 14   | NAVIGATION  
Use ideas from the consensus models and related phenomena to develop questions we can investigate. |
| 15   | DISCUSS QUESTIONS TO POST ON DRIVING QUESTION BOARD  
Provide question sentence stems to help students work on and share their questions from the last time to prepare to post them on the DQB. |
**BUILD THE DRIVING QUESTION BOARD**
Develop the DQB with contributions from all students in the class.

**BRAINSTORM IDEAS FOR DATA AND INFORMATION NEEDED**
Create an “Ideas for Data and Information We Need” poster and record the class’ thoughts on how to figure out the answers to our initial questions as we move forward.

**NAVIGATION**
Allows students to reflect on the Driving Question Board and offer suggestions for next steps.
## Lesson 1 • Materials List

<table>
<thead>
<tr>
<th>per student</th>
<th>per group</th>
<th>per class</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesson materials</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>● <em>What is happening on Mount Everest?</em></td>
<td>● 1 Earth squish ball globe with countries labeled</td>
<td>● World Map (large wall global relief map)</td>
</tr>
<tr>
<td>● science notebook</td>
<td>● 1 Earth squish ball globe with no labels</td>
<td>● Inflated 12” inflatable globe</td>
</tr>
<tr>
<td>● <em>Explain How Mt. Everest Moves And Grows</em></td>
<td>● 2 paper coffee sleeves</td>
<td>● 2 sticky notes (or this can be a regular sticky note cut in half)</td>
</tr>
<tr>
<td>● <em>Alternate: Initial Model</em></td>
<td>● Data Cards for Other Mountains and Mt. Everest</td>
<td>● Mt. Everest Notice and Wonder poster</td>
</tr>
<tr>
<td>● <em>Explain How Mt. Everest Moves And Grows or Alternate: Initial Model</em></td>
<td>● Patterns Of Change For Mountains</td>
<td>● chart paper</td>
</tr>
<tr>
<td>● <em>Data Cards on Other Mountains and Mt. Everest</em></td>
<td>● Explaining Other Mountains That Shrink</td>
<td>● markers</td>
</tr>
<tr>
<td>● <em>sticky notes (or index cards and tape)</em></td>
<td>● sticky notes</td>
<td>● Discussion Norms poster</td>
</tr>
<tr>
<td>● <em>marker</em></td>
<td>● What Causes Mountains to Shrink initial model poster</td>
<td>● What Is Causing Everest to Move and Grow initial model poster</td>
</tr>
</tbody>
</table>

### Materials preparation (20 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.
Prior to day 1:

1. Put up the global relief map in your classroom where it is viewable by all. We will refer to this as the World Map. You may wish to add a title above it.
2. Inflate the 12” inflatable globe with topography representations. You will use this again in Lesson 1f.
3. Look up the location of your town and Mt. Everest, and be ready to point out these locations on the class map.
4. In addition, look up the distance from your school to Mt. Everest.
5. Place each of the Data Cards for Other Mountains and Mt. Everest in a plastic sheet protector so they can be reused between classes. Students will revisit these over the course of the unit. Additionally, use Data Cards on Other Mountains and Mt. Everest to print a black and white copy for students to annotate and place in their notebooks.
6. A color copy of this reference can also be found in the Student Handbook.
7. On days 1 and 3, pairs of students will need the two squish Earth globe balls and the coffee sleeves to use as they analyze mountain data.

You will need a copy of the global relief map posted in a location in the room that all the students can see and gather around. This map will be used multiple times over the course of the unit.

You will need two sticky notes for day 1. One should be labeled “Our School” with the distance in miles from your school to Mt. Everest. The second should be labeled “Mt. Everest.”

You will need 5 large (4”x6”) sticky notes for day 2, one per mountain case.

Prepare a space for your Word Wall that will include space for “Words We Encounter” and “Words We Earn.” “Words We Encounter” are specialized terminology we encounter in a piece of informational text that we need to know what they mean to comprehend the information. “Words We Earn” are words that we work together to make sense of over time in the context of figuring out the phenomenon. During day 1, add earthquake and magnitude under “Words We Encounter” from the reading.

Prepare all posters using chart paper and markers:

- Day 1 - Notice and Wonder; Initial Consensus Model for Mt. Everest chart
- Day 3 - Initial Class Consensus for a shrinking mountain Model
- Day 4 - Related Phenomena, Ideas for Data and Information We Need

Determine where to set up the Driving Question Board prior to starting day 4.

After your last class on day 4: Organize the questions on your Driving Question Board into categories that emerge across all your classes. After (or as) you reorganize the board at the end of this lesson, make a typed record of all the questions that are on the board so that you can print them out or share with students to reference in groups during future classes. One way to do this is to take a high resolution photo of the board or transcribe the questions on the board into a digital or electronic document.
Lesson 1 • Where We Are Going and NOT Going

Where We Are Going

Students engage with the phenomenon through a headline claiming that Mt. Everest is growing and an article describing new data that has been collected collaboratively by Nepal and China. After developing an initial model representing what they think could be causing this, students analyze information about four other mountain peaks around the world to look for patterns in potential causes of changes to these landforms. The purpose of the anchor is to probe students’ understanding of Earth’s geologic processes, and how those processes help shape Earth’s surface. It leverages ideas that students may have about how some changes in Earth’s surface occur gradually and are almost undetectable at a glance (i.e. the growth of a mountain), while other changes may occur suddenly and are instantly observable (i.e. earthquakes). Additionally, the anchor allows students to ask questions about a single occurrence (Mt. Everest growing in elevation) and a pattern of occurrences (other mountains also changing in elevation around the world over time), and to identify the types of data and information required to answer questions about both the specific phenomenon (Mt. Everest) and the pattern of phenomena (other mountains) they’ve observed.

Where We Are NOT Going

As students share their ideas, you may hear them mention what they have heard about plates, plate tectonics, weathering and erosion. Encourage students to share their thinking, but avoid giving too much away at this point in the unit. Subsequent lessons will draw upon students’ prior knowledge from earlier years and units regarding:

- Thermal energy transfer and convection to explain how Earth’s surface is in constant motion due to movement within Earth’s mantle. Students will build on their understanding of energy transfer from Cup Design Unit and Storms Unit in which they figured out energy transfers between particles, areas of high temperature have more particle motion and therefore transfer energy faster to cooler areas, and areas of higher density sink in comparison to areas of lower density (i.e: less dense air masses rise while more dense air masses sink).
- Geologic events, such as earthquakes and volcanic eruptions, often occur in bands along boundaries between continents and oceans.
- Weathering and erosion as processes that help shape Earth’s surface, which helps explain how wind and water slow the effects of uplift. Explaining how landforms get taller or shorter will be the focus of lesson sets 2 and 3.

While we are using the uplift rate of 2 cm, this does not reflect all forces that are contributing to the increasing elevation of the mountain range. Other forces, such as the buoyancy of the plates and isostasy are contributing to this change. These ideas are above grade band. The rate is also variable based upon these forces along with the tectonic processes continually contributing to the changing landscape, and erosional rates, which will be touched on in Lesson 13.
LEARNING PLAN for LESSON 1

1 · EXPLORE AN INTERESTING PHENOMENA

MATERIALS: 1 Earth squish ball globe with countries labeled, 1 Earth squish ball globe with no labels, 2 paper coffee sleeves, World Map (large wall global relief map), Inflated 12” inflatable globe, 2 sticky notes (or this can be a regular sticky note cut in half)

Explore an Interesting Phenomenon. Show slide A. Say, Have you ever heard of Mt. Everest? What do you know about it? Hear from a few students about what they know about Mt. Everest.

Say, I saw this interesting headline recently about Mt. Everest. Read the headline off the slide stating it is the tallest mountain and that it grew. Say, Turn and talk with a neighbor about what might cause a mountain to grow? Ask a few pairs to quickly share their ideas with the class.

Locate where Mt. Everest is on a map with students. Show slide B. Bring students’ attention to the global relief map, which will be referred to as the World Map with students. Say, Let’s mark on our World Map where Mt. Everest and our town/school is located. Write “Our School” on one sticky note and “Mt. Everest” on a second sticky note.

Begin by placing a small sticky note, or half of a sticky note, labeled “Our School” to note the location of your town or school. Say, The distance from our school to Mt. Everest is ______ miles. Let’s record that on our sticky note for our school. Prior to class, write ____ miles from Mt. Everest on the “Our School” sticker for your location so that you are ready with this information.

Say, Mt. Everest is located on the Asian continent between Nepal and China. Does anyone know where the Asian continent is located on the World Map?

Ask a student volunteer to point out the location of Asia on the map. Then point out the location of the Himalayas and Mt. Everest. Place the sticky note with Mt. Everest at the location. See image to the right.

Orient to the location on the globe. ★ Distribute both Earth squish ball globes and 2 coffee sleeves to each pair of students. Hold up the 12” inflated globe (or classroom globe if you have one) and instruct students to demonstrate the following with their Earth squish ball globes with their partners. As students find these locations on their small Earth squish ball globe, verify these locations using the larger inflatable globe.

- Place each Earth squish ball globe on its own sleeve so that the northern pole is pointed to the ceiling.
- Ask each person to point to where we live on both Earth squish ball globes.
- Find India.
- Locate China and Nepal.
- Share with students that Mt. Everest is on the border between these two countries.

★ ATTENDING TO EQUITY

Universal Design for Learning: To support students in map reading during this activity section orient students to your current location on the globe as well as the United States and other notable, meaningful landmarks to students. Providing physical objects and spatial models to convey perspective can help support representation, according to the UDL framework.
This is the first of many times over the course of the unit that students will be using this class global relief map. This type of map may be a new representation for students and they may have some questions about the different features found on the map. If you have the time, you can field their questions and take time to have students make sense of the map features. But in the next lesson, the class will be spending time making sense of and identifying different features of this relief map. The purpose of visiting the map here is for students to see where Mt. Everest is located and how this location compares to where your town/school is located.

2 · READ ABOUT MT. EVEREST

MATERIALS: What is happening on Mount Everest?, science notebook

Prepare science notebooks to record noticings and wonderings. Display slide C. Have students title a new page in their notebooks “Mt. Everest Reading” and make a T-chart below the title to record what they notice and wonder as they read an article about what happened at Mt. Everest.

This is the first use of the science notebook for this new unit. You may need time to organize a new section in the notebook. It is recommended to have students do the following:

● Reserve a blank page at the start of the unit, to be titled on day 4 of this lesson when the class decides on the unit question after completing the DQB.
● After the title page, reserve 2 pages (4 pages front-to-back) for the table of contents (unless all tables of contents are at the front of the notebook).
● Reserve 8 pages (16 pages front-to-back) for the Progress Tracker.
● Number the pages so everyone begins the first investigation on the same page number (e.g., page 1 for the first page of the table of contents, page 5 for the first page of the Progress Tracker, and page 21 for the first Notice and Wonder chart they are making now).

Remind students that the notebook is their tool for recording their observations, evidence, and ideas to share with the classroom community. They should see it as a space to brainstorm and record their thinking as well as a place to show how their thinking changes as they learn more.
Gather additional information about this phenomenon from a reading. Keep slide C displayed. Distribute a copy of What is happening on Mount Everest? to each student. Tell students they will read the article with a partner.

Remind students of the close reading strategy. Display slide D. Remind students that close reading requires reading more than once and with different purposes and strategies for interacting with the text. Say, As you read with your partner, remember to use our close reading strategies we have used in prior units. Pause at the end of each paragraph and record anything you have noticed and any questions you have about what you read.

3 · RECORD WHAT IS HAPPENING AT MT. EVEREST

MATERIALS: What is happening on Mount Everest?, science notebook, Mt. Everest Notice and Wonder poster

Share noticings and wonderings as a class. Show slide E. Have a piece of poster paper ready to record what students share. Say, What were some things you and your partner noticed and wondered about what is happening to Mt. Everest? Document students’ ideas on the poster paper titled “Mt. Everest Notice and Wonder”. These ideas on the poster paper may be helpful for students to refer to when they develop their initial model later in this lesson. Some potential noticings:

- Mt. Everest has been recorded as 30 ft taller today than it was in 1856.
- Mt. Everest moves 4 cm on average every year to the NE.
- Mt. Everest increases in elevation about 2 cm on average per year.
- An earthquake occurred at Mt. Everest.
- Scientists aren’t sure if the earthquake caused a change in height.
- GPS data was used to measure changes in Mt. Everest’s location and height...like how our phone works with maps.

ADDITIONAL GUIDANCE

There are two words introduced in the reading that students will work with in multiple lessons in this unit, “earthquake” and “magnitude”. If your students bring these up as noticings and or wonderings, you may wish to add them to your Word Wall under the “Words We Encounter” section. In the next lesson, students will explore different earthquakes and be able to add to and move “magnitude” to the “Words We Earn” section of the Word Wall. In Lesson 6, students will develop a model of plates moving and what happens when they interact, earthquakes being one of these results. In lesson 6, they can add to and move “earthquakes” to the “Words We Earn” section. These two words will also be used in the next unit, Tsunami Unit, so you might want to keep them up for that unit to support students in continuing to deepen their understanding of these terms.
Add earthquake and magnitude, if desired, to the Words We Encounter section of the Word Wall.

4 - DEVELOP INITIAL MODEL

MATERIALS: Explain How Mt. Everest Moves And Grows, Alternate: Initial Model

Brainstorm possible causes for changes in Mt. Everest. Show slide F. Say, So, we found that Mt. Everest isn’t only getting taller or increasing in elevation, but it is also moving. Let’s pause and try to picture this.

Support students in visualizing that the mountain is changing in multiple planes, both vertically and horizontally, by modeling these movements using your own body. For example, as you say the mountain is getting taller you could bend your knees and then “grow” your body taller by straightening your knees. To help students visualize what direction northeast is so they can think about Mt. Everest moving this way, orient them to the cardinal directions of north, east, south, west in your classroom. Then face your body towards the north and point your right arm straight out to the east. Tell students northeast would be a point in between north and east. Then turn your body and walk in a direction that is between where you are facing north and where your arm is pointing east.

Say, Take a couple minutes with your partner and discuss your ideas for what might be causing a mountain to be changing in both of these ways:

- Possible causes for the increase in elevation of Mt. Everest
- Possible causes for Mt. Everest moving to the northeast

Develop an initial model for what is causing Mt. Everest to move and grow. Display slide G. Distribute Explain How Mt. Everest Moves And Grows to each student. Say, We are going to take a few minutes to develop a model representing what we think could be causing these changes to Mt. Everest. What do we know is happening to Everest? Use the images on the slide as a way to capture what we have all figured out about Mt. Everest so far from the reading.

- Mt. Everest is moving about 4 cm to the northeast every year.
- Mt. Everest is growing about 2 cm each year.

* ATTENDING TO EQUITY

Universal Design for Learning: Developing a model for something as large as a mountain to capture how it could be moving may be challenging for some students and they may not know where to begin. In addition, some students may benefit from seeing the location of Mt. Everest on a map as they are developing their model. Alternate: Initial Model has a mountain template from a side perspective. This handout can be used as an alternative to Explain How Mt. Everest Moves And Grows by providing a representation that allows students access to a place to represent their ideas about how Mt. Everest is changing.
Say, As you develop your model, think about where Mt. Everest is located, as seen from a birds eye view (from above) like on the map, and think about Mt. Everest the mountain. As you develop your model of what could be causing the tallest mountain to grow and move, why might it be helpful to think about not only where the mountain is located, but also what the area around the mountain looks like from above and from the side? Sample student responses:

- There might be things under the mountain that are causing it to move.
- There might be things to the side of the mountain.
- Maybe it has to do with what the mountain is made up of.
- It might have to do with where it is located.

Say, Take a few minutes to develop an initial model representing your ideas for:

- What might cause Mt. Everest to increase in elevation by 2 centimeters per year?
- What might cause Mt. Everest to move to the northeast 4 cm per year?

Give students 5 minutes to develop their models.

**ASSESSMENT OPPORTUNITY**

**Building towards 1.A.1** Develop a model showing what is happening at a scale larger than we can see to explain what happened to the different mountains to cause them to change in elevation.

**What to look for/listen for:** Students include a variety of mechanisms for the changes to Mt. Everest. We want to get as many student ideas as possible at this point. Included here are some examples of student suggestions, but this list is not inclusive or exhaustive: rocks moving from one side of the mountain to the other, snow building up on the mountain top, strong wind moving the mountain, (tectonic) plates under the mountain, hills colliding causing the mountain to grow, and earthquakes pushing mountains together.

This first initial model represents students’ ideas for how Mt. Everest moves to the northeast and increases in elevation. Later it will become a more general model to explain any mountain's change in elevation and movement on Earth. For now, any ideas students have at this point in the unit is acceptable. Over the course of the unit, each of these ideas will be explored by figuring out what tectonic plates are and how they move, weathering factors and erosion factors.

**What to do:** If a student is struggling to get started on their model, remind them that our initial model is just that - our first attempt at explaining what we think is causing the changes to the mountains. Use Alternate: Initial Model to help students begin to develop their model so they have a scaffold to use as they think about the large and small scale causes for Mt. Everest to move and grow.
5 · REVISIT CLASSROOM NORMS

**MATERIALS:** science notebook, *What is happening on Mount Everest?*, *Explain How Mt. Everest Moves And Grows*, chart paper, markers, Discussion Norms poster

**Revisit classroom norms to prepare for a whole-class discussion.** Show slide H. Have all students sit together in a Scientists Circle and bring their science notebooks and *What is happening on Mount Everest?* and *Explain How Mt. Everest Moves And Grows* with them. Have chart paper ready to develop a consensus model with the question “What is Causing Everest to Move and Grow?” at the top.

### SCIENTISTS CIRCLE

<table>
<thead>
<tr>
<th>Your students may be familiar with the Scientists Circle from a previous unit. Remind students of the norms for participation and the logistics for forming and breaking down that space. A Scientists Circle includes these important features:</th>
</tr>
</thead>
<tbody>
<tr>
<td>● students sitting so they face one another to build a sense of shared mission and a community of learners working together</td>
</tr>
<tr>
<td>● celebrating progress toward answering students’ questions and developing more complete explanations of phenomena</td>
</tr>
<tr>
<td>● focusing on where students need to go next and how they might go about the next steps in their work</td>
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</tbody>
</table>

Take this opportunity to remind the class how we listen to one another, press on one another’s ideas, and ask questions of one another, and that it’s OK to disagree with ideas but it’s important to be respectful. You can use slide H to remind students of the classroom norms (if you have developed your own set of norms, replace this slide with your norms).

### ADDITIONAL GUIDANCE

This first day of this lesson is a strategic point to have students revisit their class norms. This lesson was selected for this, because it requires students to participate in an extended amount of time in whole class discussion in the Scientists circle. Days where there is mostly whole class and small group talk are good days to select to add this norm focusing launch and wrap up, even if it isn’t written into the teacher guide. It is recommended that you add in similar revisiting of classroom norms at such strategic places in each OpenSciEd unit you teach, where you envision you could carve out an extra couple minutes being available at the start of that day of the lesson and a few minutes at the end of that day in the lesson to reflect (and debrief as a class as time permits).

**Remind students of the Communicating in Scientific Ways sentence starters.** Direct students to the *Communicating in Scientific Ways* poster or handout. Tell students that they will be developing a consensus model together. Ask them which sentence starters they might want to use to help them talk to one another. Examples include these:

* ATTENDING TO EQUITY

This is an important opportunity to emphasize that each individual has contributions to make to their community of learners. It is through differences in thinking that the class will grow their knowledge together. Throughout this unit, students will be asked to be open to sharing knowledge products that depict their current thinking and to be open to learning from classmates who share their knowledge too.
Think of an idea, claim, prediction, or model to explain your data and observations:

- My idea is ...
- I think that ...
- We could draw it this way ... to show ...

Give evidence for your idea or claim:

- My evidence is ...
- The reason I think that is ....

Other examples could come from (1) listening to others' ideas and asking clarifying questions, (2) agreeing or disagreeing with others' ideas, and (3) adding onto others' ideas.

6 · DEVELOP A CLASSROOM CONSENSUS MODEL

MATERIALS: science notebook, Explain How Mt. Everest Moves And Grows or Alternate: Initial Model, What Is Causing Everest to Move and Grow initial model poster, markers, Discussion Norms poster

Develop a classroom consensus model of what is causing Mt. Everest to move and grow. Display slide 1. Ask students to come into a Scientist’s Circle with their notebook, What is happening on Mount Everest?, and Explain How Mt. Everest Moves And Grows. Say, Last class we developed our initial models for what we think could be causing Mt. Everest to move and grow. Let’s synthesize our ideas to develop a classroom consensus model. What do we know is happening to Mt. Everest from our reading that we want represented in our model?

**Note: Use the prompts below as you develop the consensus model with your students. These are suggested prompts and responses, but use whatever representations your class agrees upon to capture the changes occurring to Mt. Everest.

<table>
<thead>
<tr>
<th>Suggested prompt</th>
<th>Sample student response</th>
</tr>
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<tbody>
<tr>
<td>Let's begin our class model by representing what we know from the data in the reading. What are some of the data that we want to be able to explain using our class model?</td>
<td>In 1856 Mt. Everest was 29,002 feet and in 2021 Mt. Everest was reported at 29,032 feet. Mt. Everest has grown 30 feet since 1856. Mt. Everest grows about 2cm each year.</td>
</tr>
</tbody>
</table>

* STRATEGIES FOR THIS CONSENSUS DISCUSSION

As an instructor, you have two goals for guiding the consensus discussion in addition to the goals listed on slide 1. Your first goal is to help students: (1) build a positive culture where putting their ideas out in the public classroom community is valued and (2) to generate a variety of initial ideas to identify that there is a lot we don’t understand yet. Highlight any areas of disagreement. Be careful not to favorably respond to any one idea over others as to not “give away” the answer.
Okay so how should we represent that Mt. Everest has grown over time?

Now that we have the growth of Mt. Everest represented, how can we add to our model to show that it moves 4 cm to the NE each year?

Share and record possible causes for these changes. After you have captured what changes the class knows are occurring at Mt. Everest, use the prompts below to capture representations of the mechanisms students think are causing these changes at Mt. Everest. Here you should anticipate many different mechanisms and include them all in the model with question marks next to each one once you establish that not everyone had this mechanism in their model. For each brief phrase mentioned (e.g. erosion, wind, plates, rocks pushing up, ice), it is OK to ask for clarification such as, What do you mean by that? or Do you have some way you want me to represent this to help illustrate how you picture what is causing this change? These questions can be followed up with asking students to share their reasoning behind their ideas, but don’t push on these questions at this time. The purpose here is to surface as many ideas as students have based on prior conceptions. It is important to make our thinking visible about possible mechanisms, regardless of whether they are accurate or not. One of the main goals of the unit is to figure out what mechanisms cause changes in the topography of Earth.

Say, Okay, our model now represents what we know is happening at Mt. Everest. Let’s add what we think is causing these changes in elevation and movement.

<table>
<thead>
<tr>
<th>Suggested prompts</th>
<th>Sample student responses</th>
<th>Follow-up questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are some of your ideas for what is causing these changes? What is causing Mt. Everest to grow and move?</td>
<td>Because it’s really cold at the top of Mt. Everest, I think that snow at the top is the cause for Mt. Everest getting taller.</td>
<td>Did other people have this included in their model?</td>
</tr>
<tr>
<td>I think that Mt. Everest is moving each year because rocks break off from one side of the mountain and move to the other side.</td>
<td>What do others think of this idea?</td>
<td></td>
</tr>
<tr>
<td>I think we should add in plates under the mountain. I am not sure if they are in the mountain or under the mountain, but I think they have something to do with the mountain moving.</td>
<td>Was this idea in your model?</td>
<td></td>
</tr>
<tr>
<td>I think we should add in wind pushing on the mountain above ground. I think this could be moving the mountain.</td>
<td>How do we want to represent this idea in our model?</td>
<td></td>
</tr>
<tr>
<td>I think we should add in water under the mountain. There is water under the ground, so maybe there is more water near Everest making it move to the northeast.</td>
<td>Where should we include this idea in our model?</td>
<td></td>
</tr>
</tbody>
</table>

**KEY IDEAS**

**Purpose of this discussion:** This initial ideas discussion should be a moment for students to share all the different potential causes they picture that could cause a mountain to move and/or grow. Over the course of the unit, students will investigate different, plausible mechanisms. At this point in the unit, any ideas students have for the causes of mountain changes is acceptable.

**Listen for these ideas:** Accept all responses. Possible mechanisms that might be shared:

- Wind
- Moving water
- Temperature differences
- Rain
- Snow
- Plates
- Climate change
ADDITIONAL GUIDANCE

If students bring up mechanisms such as plate tectonics, don't ignore them—write “plates” and put up “arrows to show movement of them” with a question mark. No need to push for it, but if it comes up, say, *We are going to focus on looking for patterns of change similar to Everest in other mountains. We can follow the patterns of change to help us figure out what is causing those changes.*

The classroom consensus model should capture students’ ideas for the causes of mountains moving and growing.

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7 · NAVIGATION

**MATERIALS: None**

Consider what might be happening at other mountain locations. Show slide J. Say, *What about other mountains? There are a lot of mountains on Earth and Mt. Everest is only one of them. What do you think we might see at other mountain peaks and other mountain ranges?* Use the questions on the slide to begin thinking about what we think is happening with other mountain ranges.

- What are some other mountains or mountain ranges you know about?
- Do you think that they are changing in similar ways too?

Follow-up with additional questions as needed:

- *If we looked at other mountains on Earth, would we see similar patterns in mountains changing in height over time?*
8 · COMPARE DIFFERENT MOUNTAIN PEAK INFORMATION CARDS

MATERIALS: Data Cards on Other Mountains and Mt. Everest, science notebook, Data Cards for Other Mountains and Mt. Everest, 1 Earth squish ball glove with countries labeled, 1 Earth squish ball globe with no labels, 2 paper coffee sleeves

Find out more about the area where Mt. Everest is located. Show slide K. Set up a data table together with students recording it in their notebook. Tell students to open to the next blank two pages so that they have both the left and right hand side available to use. Refer to the image on the slide for an example of this.

Remind students that the goal of our data analysis is to look for patterns in any changes in height or movement as well as any additional information that gives us ideas about possible mechanisms or causes for those changes. Ask students what kind of data we want to have to help us figure out more about how mountains change over time. When the class agrees on one type of data, students should list that on the far left column of the chart in their notebook. Some examples of types of data students may suggest the class should collect include:

- Height of the mountain
- Movement of the mountain
- Changes in height for the mountain
- Location of the mountain
- Earthquake activity

Once the data table is set up, tell students that the information cards will probably have more information than just whether the mountains are changing. If they see something else that they think might also help explain what is happening at Mt. Everest, add a row to their data table called “other” and include that data (see example below).

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Data</th>
<th>Causes for changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of mountain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement of the mountain</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in height</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* SUPPORTING STUDENTS IN ENGAGING IN ANALYZING AND INTERPRETING DATA

The mountain case cards include multiple pieces of information about the mountain peaks and the areas/ranges they are part of including types of elevation changes, lateral movement that the peaks are experiencing, weather/climate, samples of rocks found in the mountain and other interesting facts. These cards will be revisited and analyzed numerous times over the course of the unit as students build their conceptual understanding of the processes causing changes to Earth’s surface. This is the first time students will begin thinking about causal and correlational relationships using data. In this first pass, students are only expected to be thinking about what causes mountains to change. But through the initial discussions in this lesson and the eventual investigations and discussions through the rest of the unit, students will progress in their ability to analyze data and identify causal vs. correlational relationships.
Distribute a copy of Data Cards on Other Mountains and Mt. Everest to each student and a Mt. Everest in the Himalayas card to each group of students as reference. The Data Cards on Other Mountains and Mt. Everest reference sheet should be printed in black and white and provided to each student so they can annotate it and include it in their student notebook. In addition, distribute both Earth squish ball globes and 2 coffee sleeves to each pair in a group to use as reference.

In the next part of the lesson, students will read about five different mountain peaks and their ranges. This first one is about the Himalayas where Mt. Everest is located. Analyze this first case site as a class to find the types of data we are looking for to help us figure out more about changes to other mountains besides Mt. Everest.

**ADDITIONAL GUIDANCE**

Some students may believe that a mountain range needs to span countries or continents to be considered not just a string of mountains, but a range. A mountain range is simply a series of mountains connected by high ground. In everyday language we tend to refer to structures with names that do not match their actual scientific names, such as the Appalachian Mountain range. In the scientific context, many of these structures are actually orogenic belts composed of smaller mountain systems. It may be worth stopping to operationally define the word mountain range as a class before proceeding with the lesson.

Below are some examples of what students might suggest to underline or annotate from the Himalayas card and add to the data table in their notebook.

<table>
<thead>
<tr>
<th>Possible student suggestion</th>
<th>Possible student reasoning why to underline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underlining the location of the Himalayas.</td>
<td>Knowing where the mountain range is located might help us to figure out what is going on around Mt. Everest.</td>
</tr>
<tr>
<td>There is another really tall mountain located in the Himalayas called K2.</td>
<td>Maybe all the mountains here are growing taller here since two of the tallest mountains are found in the same area.</td>
</tr>
</tbody>
</table>
There is a lot of snow and ice in this area. Maybe the new heights are from the snow and ice that is building up here.

As the class agrees on what is important from the Himalayas card, they should add that information to their notebook. An example of a data table is included below:

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Data</th>
<th>How this data connects to mountains changing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height or elevation of mountain</td>
<td>Everest is 29,032 feet. Another mountain in the Himalayas is also very tall.</td>
<td>Maybe all the mountains in the Himalayas are tall.</td>
</tr>
<tr>
<td>Earthquake activity</td>
<td>There are many large earthquakes in the area.</td>
<td>Maybe earthquakes are connected to mountains moving.</td>
</tr>
<tr>
<td>Other data</td>
<td>There is a lot of snow and ice in the Himalayas.</td>
<td>Maybe this is why the height keeps getting taller.</td>
</tr>
</tbody>
</table>

**ADDITIONAL GUIDANCE**

The last column is for students to record their initial ideas for how the data could help figure out the causes behind the changes to Earth's surface, specifically mountains at this time. Any ideas students have should be accepted. Notice the examples in the last column are more similar to wonderings. That is okay and you should even encourage students to record those as well. The purpose of asking students to think about what could cause these large changes, or how the data connects to mountain changes, is to get all their ideas shared.

Students will continue to look for patterns of cause and effect as they continue through the unit. For example, some students may think that there is less wind in other parts of the Himalayas compared to Mt. Everest since it is the tallest mountain in the world, or they may think that there is less snow on other mountains in the Himalayas that are shorter than Mt. Everest. All of these ideas as causes are acceptable in this first lesson.

**Assign one mountain case card to each student within a small group.** After reading through the Mt. Everest in the Himalayas card together, form small groups of three to four students. Each student within a group will read one of the remaining five Data Cards for Other Mountains and Mt. Everest. Organize the assignment of the five mountain cards so that more than one student in the class is reading each mountain card. Direct students to follow the same strategies we just used as a class to find pieces of data from these other mountains that could help us figure out what causes mountains to change over time. In addition to the maps on the front and back of the Data Cards, encourage students to use the two Earth squish ball globes to make sense of where the mountain they are analyzing is located on the globe. Give students about 8 minutes individually to read through the card they have been assigned.
During this first analysis of the mountain case cards, students should look for data that could help the class figure out causes for mountains to change by finding potential patterns in the data. It is not necessary at this point for students to record all the data off of the mountain cards. Instead, through their analysis of the material they should pull out only the data that could help explain changes in elevation or lateral movement of mountains.

**ALTERNATE ACTIVITY**

Though the Data Cards for Other Mountains and Mt. Everest are on cardstock and placed in plastic sheet protectors since they will be revisited multiple times throughout the unit, you may wish to provide your students a black and white copy of these. In this first lesson, students may wish to annotate, highlight, or notate different pieces of information as they begin thinking about causes and processes that could be common across different mountain cases for the changes the mountains experience. Use Data Cards on Other Mountains and Mt. Everest to make student copies.

**9 · COMPARE MOUNTAIN SITE LOCATIONS**

**MATERIALS:** Patterns Of Change For Mountains

Share data across mountain cases and look for patterns of change between the different mountains. Display slide L. Distribute one copy of Patterns Of Change For Mountains to each student. Tell students they should each take a turn sharing the data they found for their mountain case. As each person shares they should fill in Patterns Of Change For Mountains with any data for growth or decreases in height. Then as a group, they should discuss what patterns of change they see between the different mountains and fill in their handout so they are ready to share with the class.

**10 · SHARE PATTERNS IN GROWTH AND MOVEMENT BETWEEN DIFFERENT MOUNTAINS**

**MATERIALS:** science notebook, Patterns Of Change For Mountains, World Map (large wall global relief map), large (4"x6") sticky notes or quarter sheets of paper with tape, sticky notes

Convene in a Scientists Circle and share patterns we noticed between the different mountain peaks. Display Slide M. Say, *Let's share what data we found from the different mountain cases and add some of this to our map. We will begin by identifying what other mountains you analyzed and where they are located on our map.* Students should be able to help identify where the mountain is found from what they read on the data card, but they may need help identifying where the location is on the global relief map. Using a small sticky note, mark the different locations of the mountains on the map.
Say, Now let's share what you found about these different mountains. As different people share and we agree on what data will be important for us as we investigate what is causing mountains to change, we will record this data near the different locations. So, what are some of the data you found for the different mountains that will help us figure out why mountains can change over time?

Record all of these that the class agrees makes sense to include on a large 4” x 6” sticky note. Using the sticky notes or quarter sheets of paper, annotate the different mountain peak locations with similar patterns of data, and place it on the map near the mountain peak the data is referring to. These patterns of data should be pieces that we feel will help us figure out Mt. Everest as well. As students share, record the different data on the sticky notes and post them on the map in the location of the mountain range. See the example to the right.

Some examples of data students may suggest to record on the sticky notes for the different mountain peaks is included below:

**Mt. Mitchell:**
- Mt. Mitchell moves on average 3 cm each year towards the west.
- The Appalachian mountains are ancient.
- They are believed to have been as tall or taller than the Himalayas.
- The peaks are decreasing in height and the valleys are getting deeper.
- There is volcanic rock in these mountains. (Does that mean there are volcanoes here?)
- There are no active earthquakes.

**Mt. Cook:**
- There are regular earthquakes in the area.
- One earthquake caused part of the ocean floor to rise above the water.
- These mountains are increasing in height 1-2 cm/year.
- This area is moving 6.9 cm towards the north.

**Mt. Aconcagua**
- These are moving about 3 cm per year to the north.
- The mountains are the tallest mountains after the Himalayas.
- The tallest peak is 22,838 ft tall.
- The tallest active volcano can be found in these mountains.
- These mountains are the same age as the Himalayas.
- These mountains are still increasing in elevation through growth spurts.

**Mount Hotaka**
- These mountains are younger than the Himalayas.
- There are several active volcanoes in these mountains.

**Mount Narodnaya**
- These mountains are much older than the Himalayas and about as old as the Appalachians.
- Earthquakes can occur here, but they are small and not common.
- These mountains are moving about 2.5 cm to the east each year.
- This mountain is much shorter than Mt. Everest.

**Look for patterns across the different mountains.** Say, *Now that we have recorded the pieces of data for each mountain, let’s share the patterns of similarities and differences that your group found between the mountain cases.* Use the prompts below to lead a discussion about what patterns students noticed between the different mountains and how they change. You may wish to add some of these to the large sticky notes as students share.

<table>
<thead>
<tr>
<th>Suggested prompt</th>
<th>Sample student response</th>
</tr>
</thead>
</table>
| *What are some patterns of change you noticed between the different mountains?* | Almost all the mountains are growing except for Mt. Mitchell in the Appalachians and Mount Narodnaya in the Urals.  
Almost all the mountains are moving in one direction or another, but they aren’t all moving in the same direction.  
Most of the mountains are moving to the north. But there is one moving west and one moving east.  
The mountains in our cases are all in different parts of the world.  
Some are near the ocean and others are not ... like the Urals and the Appalachians are both mountains that are not near water and they are both shrinking.  
Besides the Himalayas that are growing and not near water, all the other mountains that are growing are near the ocean.  
The Urals and the Appalachians are much older than the Himalayas, but the rest are younger or about the same age as the Himalayas. |
The mountains have different types of weather depending on where they are located.

Fossils can be found in most of the mountains.

Some of the mountains have volcanic rock.

Some of the mountains have similar types of rock, like sandstone or limestone.

How close a mountain is to an ocean affects how tall a mountain is because of wind from the water.

How old a mountain is might affect whether it is growing or not because the Urals and Appalachians are much older than the Himalayas and they are both shrinking.

If there is volcanic rock on the mountain, maybe volcanoes can cause mountains to change too?

I saw there were fossils of marine animals in some of the mountains...does this mean the mountain used to be under water?

**KEY IDEAS**

**Purpose of this discussion:** Surface ideas for causes of change to mountains over time based on patterns students notice. There will be uncertainty about the causal mechanisms shared, but that is okay as these ideas will help motivate us to want to investigate more about the different potential causes of change.

**Listen for these ideas:**

- Accept all reasonable responses connected to the data in the cards.
- There are other mountains that are getting taller too.
- There are some mountains that are changing in height by shrinking.
- Some other mountains have earthquakes happen too.
- Mountains are different ages, some much older than Mt. Everest and some younger.
Other mountains also shift in location.
- Some mountains have volcanic rocks in them.
- Some mountains have sedimentary types of rock like sandstone and limestone.
- Some mountains are located near water and others are only on land.

Other ideas that may be shared but are not critical to bring out at this time include: ideas around the fossils found, or the type of weather experienced.

End of day 2
students to look back at the initial model they developed for Mt. Everest and think about what they would change in the model to represent a decrease in elevation.

12 - ADD TO THE CLASSROOM CONSENSUS MODEL

MATERIALS: science notebook, Explaining Other Mountains That Shrink, What Causes Mountains to Shrink initial model poster

Convene in a Scientists Circle. Display slide 0. Say, Last class we found data that some mountains are not growing but are shrinking. So if all mountains aren't growing, then our initial consensus model won't explain what is happening to every mountain. As a class, let's develop a model to capture the ideas we have for what we think might be causing other mountains to shrink.

<table>
<thead>
<tr>
<th>Suggested prompt</th>
<th>Sample student response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Let's begin our class model by representing what we know from data. What are some things we should be sure to include in our class model? How should we begin our model of a shrinking mountain?</td>
<td>We should include a mountain like we did for Everest, but it should be shorter than our model for Everest.</td>
</tr>
<tr>
<td>So these mountains that are shrinking are shorter than Mt. Everest now, but were they always?</td>
<td>Yeah, both the mountains we read about that are shrinking are shorter than Everest.</td>
</tr>
<tr>
<td>If we want to model what causes a mountain to shrink, then how can we capture that these mountains were as tall or taller than Mt. Everest but are now shorter?</td>
<td>No ... it says they were as tall or taller than Everest.</td>
</tr>
<tr>
<td>Okay, so how should we represent that these mountains have shrunk over time?</td>
<td>We should draw more than one image of the mountain ... like before and after.</td>
</tr>
<tr>
<td></td>
<td>Yeah, so we can show what happens over time to the mountain.</td>
</tr>
<tr>
<td></td>
<td>We should have a tall mountain for the before section, then a shorter mountain for now.</td>
</tr>
<tr>
<td></td>
<td>We could also add an arrow pointing down from the top of the mountain to represent it getting shorter.</td>
</tr>
</tbody>
</table>

* STRATEGIES FOR THIS CONSENSUS DISCUSSION

Include all ideas at this point in the unit as part of the consensus model. The purpose of developing this model is to surface ideas students have for what could be causing changes to Earth. If everyone doesn't agree with some of the ideas shared, then include the ideas as questions or with question marks. Don't worry about fleshing out every similarity or difference. For example, you can say to the group, So it sounds like some people have X, but not everyone is totally convinced yet. Let's put it up with a question mark. Does everyone agree that we're not totally in agreement about X? Consensus can mean we agree that we're not in consensus.
What are some of our ideas for what causes these changes? What is causing some mountains to shrink?

I think maybe there are things happening underneath the mountain, like maybe the plates are moving or breaking.

Or maybe the snow at the top of the mountain is melting and that is causing the mountain to shrink.

I think wind and rain could be causing the mountain to shrink by erosion.

An example of an initial consensus model for a shrinking mountain can be found here:

KEY IDEAS

**Purpose of this discussion:** This initial ideas discussion should be a moment for students to share all the different potential causes they picture could make a mountain shrink. The goal is for students to investigate different mechanisms to figure out which ones are causing the changes to a mountain. Any ideas students have for causes of mountain changes, even if they are correlational in nature, is acceptable.

**Listen for these ideas:** Accept all responses. Possible mechanisms that might be shared:

- Wind
- Moving water
- Temperature differences
- Rain
- Snow
- (Tectonic) Plates
- Climate change

In addition to these ideas, students may share ideas around the types of rock the mountains are made of, or the fact that there are fossils on the mountains, but these ideas do not need to be pulled out at this time if they haven't been shared. The inclusion of the presence of these types of rocks could be evidence for some of the processes (e.g. erosion or weathering) that students may want to include in their model. Students will revisit the mountain case cards over the course of the unit to continue to build their models and fully explain what is occurring at the different locations.
13 - BRAINSTORM RELATED PHENOMENA

MATERIALS: science notebook, Related Phenomena poster, sticky notes

Brainstorm related phenomena. Display slide P. Ask students to turn to a new blank page in their science notebook and title it “Related Phenomena.” Then they should draw a T-chart on the page. The left column should be titled “Examples” and the right column titled “Causes.” Reference image on slide.

Say, Think back on all your experiences where you’ve noticed a change in the surface of the land or landforms, such as hills, mountains, shorelines, or other features on Earth’s surface. These changes could be over a very short period of time or a long period of time and/or they could be big or small changes to the land. If you can’t think of any that happened where you live but you can think of a change that you saw happen somewhere that you visited or that you read about, that is okay too. Take a couple of minutes and record all of the related phenomena you can think of in your notebook and what you think the causes of these changes might be. Share with a partner and think about causes. Display slide Q. Say, Take a few minutes to share with a partner your related phenomena examples and potential causes. Then together think about the examples you have and whether the causes for these changes would be similar to what could be causing Mt. Everest to change.

After students have had some time to share with a partner, display slide R and bring the class back together. Ask students to share their related phenomena examples and potential causes for these changes. Say, As you share, tell us how you think it could be related to how mountains change. As students share their ideas, record the examples and causes on sticky notes. Add these sticky notes onto the appropriate sections on the Related Phenomena poster to be kept in the classroom to reference later.

ADDITIONAL GUIDANCE

The procedure for developing the related phenomena poster is different here than in other units. We recommend adding ideas to the poster on sticky notes. In subsequent lessons when we revisit this poster, we want to be able to add to it and move things around. As we figure out more about causal and correlational relationships that contribute to mountain and landscape change, causes for some related phenomena may become more apparent for students. Some students may realize an example might belong under causes and vice versa, and the mobility of sticky notes allows for easy rearrangement of ideas.

14 - NAVIGATION
**MATERIALS:** science notebook

**Record new questions.** Show slide S. Have students write down new questions they are now thinking about for what could be causing mountains to change in elevation and move, and other land near them to change. They should write them in their science notebooks before they leave class or on a separate paper to be collected. Students should come to the next class prepared to share those questions with others. If you are short on time, this can be done as home learning. Let the class know that at the next session we will share out all of our questions and build a DQB to help figure out what's causing mountains to change in elevation and move.

**ASSESSMENT OPPORTUNITY**

You can read students' questions as a formative assessment prior to the next class and then again later in the unit to see how students' questions are developing. Look for students to be asking questions about what causes could lead to land and landforms, such as mountains to change over time.

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**End of day 3**

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15 · **DISCUSS QUESTIONS TO POST ON DRIVING QUESTION BOARD**

**MATERIALS:** science notebook, sticky notes (or index cards and tape), marker

**Return to the questions students generated earlier and develop new questions.** Say, *Last class, we brainstormed a lot of questions about what could be causing mountains to grow, shrink and move, and other similar phenomena. Today, we're going to post our questions to our Driving Question Board and begin thinking about what we're going to investigate in order to figure out what's happening to cause Mt. Everest and other mountains to grow or shrink, and move.*

- **Share questions with a partner.** Show slide T. Pull out their questions from the last class or their home learning.
  - They should write one or two questions on sticky notes with large, **BOLD** writing so everyone can see. They should write only one question per sticky note.
  - Share their questions with one partner in the circle.
  - Remind students that the questions do not all have to start with how or why, but they should be questions that (1) we can answer through investigation and (2) will help us explain how a mountain can change.

**COLLABORATION**

As students learn to go public with their ideas, it can help to stimulate and support their individual thinking by sharing their questions with one person first, before having to go public with their questions in the large group. If your class is very comfortable sharing ideas in public already, you can omit this step in the lesson.
16 · BUILD THE DRIVING QUESTION BOARD

MATERIALS: What is happening on Mount Everest?, Explain How Mt. Everest Moves And Grows, Explaining Other Mountains That Shrink, Patterns Of Change For Mountains, markers, sticky notes

Record individual questions. Make sure markers and sticky notes are provided. Say, Let’s look back at our noticing and wonderings, What is happening on Mount Everest?, Explain How Mt. Everest Moves And Grows, and Explaining Other Mountains That Shrink, and Patterns Of Change For Mountains to capture our questions about what is happening in these different cases where mountains are changing and where other changes are happening to the land around us. We will use these questions to form our Driving Question Board.

To prompt an array of questions, remind students to think carefully about the changes happening to Mt. Everest, any changes to the mountains described in the cards, and other related phenomena.

Present slide U. Give students at least 3 minutes to generate their questions on sticky notes. Encourage students to write more than one question, but only one question per sticky note, and put their initials in pencil on the back of each.

While students write questions, move the Related Phenomena poster to hang next to the Initial Consensus Model posters where all students can see it from a Scientists Circle. These posters together will serve as the space where students can add their questions to build their DQB, and will be referred to as the DQB in subsequent activities and lessons.

Gather in a Scientists Circle around the DQB. Present slide V. Have students bring their science notebooks and all of their sticky note questions along with a chair and form a circle in a location where everyone can see the two Initial Consensus Models and the Related Phenomena poster. These three posters will serve as the DQB for this unit.

Remind students that our goal is to capture all our questions to build a DQB. Say something like, It looks like you have a lot of really good questions about what could be causing changes to different mountains and different locations on Earth. It is important that we hear everybody’s questions, and we might find that we have similar questions. To help us group similar questions, let’s try to post each question on a spot on one of the Initial Consensus Model posters or on the Related Phenomena poster, or in between them.

Review these steps for forming the DQB:

- The first student comes up to the DQB with a sticky note, faces the class, and stays standing.

* SUPPORTING STUDENTS IN ENGAGING IN ASKING QUESTIONS AND DEFINING PROBLEMS

If students forget to explain how or why their questions are linked to someone else’s question, press them to try to talk through their own thinking. This is a key way to emphasize the importance of listening to and building off each other’s ideas, and to help scaffold student thinking.

Don’t worry if some questions raised are not part of topics in this unit. Over time, with practice in this type of activity, students will get better and better at forming testable questions in the scope of the DQB. If students can’t figure out which question to connect theirs to, encourage them to ask the class for help. After an idea is shared, ask the original presenter if there is agreement and why, and then post the question.

If a question is similar to (or the same as) another one, have the student place it on top of that question so other students can
● The student reads their question off the note and then posts it on the DQB near the section of the consensus model or related phenomena it is most related to.
● The student selects the next student whose hand is raised.
● The next student reads their question and posts it on the DQB. This student also says what other posted questions it relates to and explains why or how it relates. ✪
● The student then selects the next student whose hand is raised. ✪
● This process continues until everyone has had a chance to post a question.
● Remind students to keep track of whether their question was already asked, put a checkmark on that sticky note if it was, and then select a different question to share.

**ASSESSMENT OPPORTUNITY**

**Building towards:** 1.B Ask questions that arise from our analysis of information showing that Mt. Everest and four other mountain peaks are changing to seek additional information about what caused the changes (effects) we read about.

**What to look for/listen for:** Students contributing questions about the event on Mt. Everest, about mountains changing in elevation, mountains moving, about earthquakes, and other landforms (eg: volcanoes). Look for students’ questions to (1) move between different spatial and temporal scales, (2) focus on the Mt. Everest event, and (3) focus on the similar and different patterns of change for other mountains.

**What to do:** If students are struggling to generate questions in each of these areas, cue them to use the crosscutting concepts of Patterns and Cause and Effect as a lens to help them brainstorm different kinds of questions to ask. (Note: You do not need to use these words explicitly, for example, cause and effect, but can refer to them as the “cause of the mountain getting taller”).

An example of one such DQB is shown here.

Point out that many of the questions are connected to how and why different mechanisms could be the cause of similar changes and how the same mechanisms could cause different things to happen at different places. Suggest that including these questions under a single driving question could remind us of how the work on any one question is in the service of all our questions. Propose that “What causes mountains to move, grow or shrink?” could be a single driving question that most of our questions could fit under.

visualize how many questions are identical or related. Emphasize that this provides us with evidence of where many people are thinking about similar things.

✶ **ATTENDING TO EQUITY**

Having the student who volunteered and posted a question choose the next student to share (from those whose hands are raised) is a great way to turn over the pacing and cadence of this group work to the students. Reuse this technique in future Scientists Circles to encourage increased student agency in the classroom learning community. When you do this, take a seat with the students in the circle to position yourself as an equal member of the learning community who is listening, making sense of questions, and trying to figure this out. If you have questions you want to share with the group, raise your hand and wait for someone to call on you.
In this lesson, students are wondering about the overarching question, “What causes mountains to move, grow or shrink?” Over the course of the unit, as students learn more about the forces and processes that cause mountains to change in location and elevation, this question will be revised to, “What causes Earth’s surface to change?” While eventually, students will be wondering this question, this lesson starts off by considering only changes to mountain growth and location. It is important to start with this question to give students agency in later lessons to change this overarching question as we learn more throughout the unit.

Once the class agrees to this, write it in large letters on a half-piece of chart paper and hang this banner over the top of the entire DQB. Remind students that we can revise this question as we continue to figure out new things in future lessons. Ask students to go to the blank page they saved in their notebook for the title of this unit and record this title now.

After your last class on day 4: Organize the questions on your Driving Question Board into categories that emerge across all your classes. After (or as) you reorganize the board at the end of this lesson, make a typed record of all the questions that are on the board so that you can print them out or share with students to reference in groups during future classes. One way to do this is to take a high resolution photo of the board or transcribe the questions on the board into a digital or electronic document.

Some examples of categories that might emerge:

- Causes of mountains
- How land moves
- Earthquakes
- Wind, rain, snow
- Volcanoes
- How long it takes for a mountain to change

17 · BRAINSTORM IDEAS FOR DATA AND INFORMATION NEEDED

MATERIALS: science notebook, Ideas for Data and Information We Need poster, DQB (around the two consensus models and related phenomena), markers

Brainstorm ideas for data and/or information needed. Display slide W. Read the slide aloud. Stay in the Scientists Circle and arrange students into groups of 3. Give students 3 minutes to talk with this small group to generate ideas about the types of data and information they would need to answer their questions on the DQB. Say, Sometimes when scientists are trying to decide on their next steps, they need to look back at their questions and figure out what data or information they still need. Let’s do that now.
For the next three minutes, have groups of students generate their list. Then, instruct students to take one minute to write their ideas in their science notebooks on a new page titled “Investigation Ideas (Information and Data We Need)” using a table like the one below.

<table>
<thead>
<tr>
<th>Investigation Ideas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Information and Data We Need)</strong></td>
</tr>
</tbody>
</table>

As students are doing this, hang the Ideas for Future Investigations and Data We Need poster right next to the DQB.

In the remaining 9 minutes, have students reconvene standing in a semi-circle around the Ideas for Future Investigations and Data We Need poster so all can see it. Give each group of students about one minute to report out the data and information that could answer their questions. Record a list of Information and Data Needed that will remain public throughout the unit. Make sure all groups get to share at least one idea.

**Build the poster with students’ ideas.** Tell students you want everyone’s ideas to be shared and represented on the poster. Say something like, *To make sure we have your ideas up here, I will pass a marker to the first person on the edge of the circle. That student should share one idea. I will write it up and number it. Once I’ve almost finished writing it, that student should pass the marker to the student next to them. The second student then shares an idea. If that idea is on the poster already, the student should say which idea it is and how it is similar. I will put a tally mark next to it. The marker is then passed and we continue until we have heard once from everyone in the class. If you have additional ideas that don’t end up on the poster, feel free to raise your hand after the marker makes it all the way around the circle. If we run out of time, we’ll pick up here in the next class. And if you think of new ideas as we go, feel free to jot them down. We should always be thinking of ways we can add to this list.*

A sample poster from one class of students is shown here.

**Celebrate the formation of a joint enterprise.** Once this poster is built, celebrate that they created a joint mission and proposed action plan to guide the work of our learning community for weeks to come. Say something like, Wow, We have accomplished so much. We now have a mission to accomplish as a class, thanks to all the questions you shared and how you connected them. These questions really represent what we hope to figure out. And we have a lot of ideas for investigations and data sources we can work with. I am very excited for us to start investigating all of these. I have lots of additional data and equipment for us to use that are well matched to the things you’ve said we need. Let’s plan to start exploring some of this in our next lesson.
Prioritize one set of ideas for investigations. If time permits, say something like, I noticed we have many different ideas for what could be causing the changes we saw in the different mountains. What cause makes sense to figure out more about first? Give students a minute or two to turn and talk with a partner.

18 · NAVIGATION

MATERIALS: None

Decide where to go next. Display slide X. Say, As you look back at the DQB and think about the ideas shared for investigations and types of data we would want, what makes sense to explore first? Talk with a partner about your ideas:

- What potential causes did we identify as a class for Mt. Everest changing? What seems the most likely cause to you and why?

In our next class, we will think more about these potential causes and begin investigating them.

ADDITIONAL GUIDANCE

Remind students to keep their science notebooks organized by writing a title on each page and updating their table of contents. They can do this when they have extra time at the beginning or end of class, or during homeroom or homework time.

Additional Lesson 1 Teacher Guidance

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA

CCSS.ELA-LITERACY.SL.6.1.A
Come to discussions prepared, having read or studied required material; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion.

Students will be reading multiple sources of informational text to pull out data that could serve as causes for change over time of different mountains. They will use the information they have found in the articles in the class discussion to develop initial models representing the changes occurring to different mountains. They will need to draw on evidence they find in these texts and be ready to support the pieces they cite from the reading.
CCSS.ELA-LITERACY.RI.6.3
Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes).

Students use close reading strategies to analyze an article to figure out how mountains are measured and what is occurring at Mt. Everest. The article includes information about how Mt. Everest is changing in both height and location over time. Students will use this information that they analyze as they develop an initial model about what could be causing Mt. Everest to change over time.