Volcano Hunters

DEVELOPER: Twig

GRADE: 7 **| DATE OF REVIEW:** June 2023

Educators Evaluating Quality Instructional Products

Volcano Hunters

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E

TOTAL SCORE: 8

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	3	3

Click here to see the scoring guidelines.

This review was conducted by NextGenScience using the EQuIP Rubric for Science.

CATEGORY I CRITERIA RATINGS			CATEGORY II CRITERIA RATINGS			CATEGORY III CRITERIA RATINGS		
A.	Explaining Phenomena/ Designing Solutions	Adequate	**A.**	Relevance and Authenticity	Extensive	**A.**	Monitoring 3D Student Performances	Extensive
B.	Three Dimensions	Adequate	**B.**	Student Ideas	Extensive	**B.**	Formative	Extensive
C.	Integrating the Three Dimensions	Extensive	**C.**	Building Progressions	Adequate	**C.**	Scoring Guidance	Extensive
D.	Unit Coherence	Extensive	**D.**	Scientific Accuracy	Extensive	**D.**	Unbiased Tasks/Items	Extensive
E.	Multiple Science Domains	Adequate	**E.**	Differentiated Instruction	Adequate	**E.**	Coherence Assessment System	Adequate
F.	Math and ELA	Extensive	**F.**	Teacher Support for Unit Coherence	Extensive	**F.**	Opportunity to Learn	Extensive
			G.	Scaffolded Differentiation Over Time	Extensive			

Volcano Hunters

EQuIP RUBRIC FOR SCIENCE EVALUATION

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. The unit is strong in many areas, including offering several opportunities for students to interact with, respond to, and make sense of real-time, three-dimensional examples of events that happen in nature.

During revisions and/or use in the classroom, the reviewers recommend paying close attention to the following focus areas in order to strengthen materials:

- **Providing print versions of the Teacher Guide and Twig Journal** that align with the online teacher directions and student version. The scores in this report are only valid for the current version of the online, interactive version of the materials.
- **Supporting students to feel as if they are driving instruction.** Although student questions are currently elicited, few supports are provided to ensure that those questions will be referred to and positioned during lessons such that students feel like the activities are motivated by their own questions.
- **Aligning messaging about how to support vocabulary acquisition**. Currently, the in-lesson teacher directions for supporting multilingual learners are research based, but they conflict with the guidance found in the Vocabulary and Language Guide provided with the unit.
- **Supporting teachers in using all parts of the assessment system together**. Teachers currently have extensive supports for using some parts of the assessment system, but supports for other parts, especially the Benchmark Assessments, are missing.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met, and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes. In these cases, the criterion definitely WAS met. The purple text is simply not part of the argument for that Extensive rating.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that learning is driven by students making sense of phenomena because learning is driven by students figuring out an anchor phenomenon, investigative phenomena, and completing a design challenge related to a problem to solve. Throughout the module, learning is connected to phenomena and student questions, but students may often be unsupported to feel as if they are driving the learning process.

Phenomena are the focus of most of the instruction in the unit, and all activities are connected in some way to making sense of the anchor phenomenon. Students revisit the anchor phenomenon often in the module to add layers of explanation based on learning. Related evidence includes:

- Lesson 1, Session 1: Students are asked to read descriptions of different cities, view a map of where those cities are in the world, and view pictures related to each city. Students then make observations of rock samples and read and sort newspaper headlines with historic data on eruptions and impacts in each area. Students are asked to write observations (e.g., that some communities near mountains experience volcanoes and others do not). The teacher is told to “Synthesize their observations and reframe them as the anchor phenomenon on page 2 in their Twig Journals. Share that they will complete the explanation section at the end of the module.
- Throughout the module, students use a Phenomenon Tracker at the end of many sessions. For example, in Lesson 1, Session 3, students visit the Phenomena Tracker Routine and reflect on how their learning helps them explain the anchor phenomenon and investigative phenomena. However, note that the tracker routine may be very time consuming so teachers might skip it. Therefore, it is unlikely that it will be used in all classrooms.
- Various investigative phenomena are used throughout the module as the focus of individual sessions, but they all connect to the anchor phenomenon. For example, in Lesson 1, Session 4, the investigative phenomenon is that “rocks have different observable properties depending on where they are found” on Earth.

- Lesson 1, Session 8: At the end of the session the teacher is told, "Display the Class Wonder Questions chart and review the Anchor Phenomenon. Support students in summarizing the Wonder Questions that have been looked at in full or in part so far. Ask students to discuss which new aspects of the Anchor Phenomenon they can now explain. Have students write their partial explanations as a short paragraph on page 3 in their Twig Journals."
- Lesson 2, Session 1: Students observe a new investigative phenomenon (a comparison of peoples' homes in Indonesia before and after a volcano erupts). This phenomenon connects to the overall anchoring phenomenon and becomes the new focus of instruction for the new lesson.
- Lesson 2, Session 2: The lesson begins by referring back to the activity from Session 1 (observing two different chemical reactions), turning it into a phenomenon (lava from different volcanoes is different) about which students could have curiosity. Prompts are not provided to elicit students' questions about that investigative phenomenon — by asking, "why is the lava different?" for example. The discussion instead shifts to the wonder question (or the student wording equivalent) "What happens during an eruption?" (slide 23). Students are asked, "What effect do you think the slope and lava thickness would have on the behavior of lava during an eruption? Think about the pieces of rock that are also erupted from a volcano. What effect do you think these additional materials will have on the movement of lava? How can we test our ideas?" Sense-making about the investigative phenomenon therefore does not drive the learning in this session, although learning is still connected to sense-making of the anchor phenomenon.
- Lesson 2, Session 4: The session lists an investigative phenomenon ("different volcanic eruptions have different effects"). Students play a game to observe part of the investigative phenomenon by comparing different characteristics of different eruptions.
- Lesson 2, Session 6: At the end of the lesson, the teacher is prompted to "Display the Class Wonder Questions chart and review the Anchor Phenomenon. Support students in summarizing the Wonder Questions that have been investigated in the module and ask students to discuss which new aspects of the Anchor Phenomenon they can now explain. Have students complete their explanations on page 3 in their Twig Journals."
- Lesson 3, Session 6: At the end of the module, students return to the anchor phenomenon. "Which parts of the Anchor Phenomenon can you now explain?" (slide 94). The teacher is told to "Have students complete their explanations on page 3 in their Twig Journals."

Student questions and ideas are elicited, and some support is provided to connect them to instruction. However, little support is provided to ensure students authentically feel as if their questions and ideas are the drivers for instruction. Student-driven instruction currently requires the teacher to closely follow the Module Wonder Questions handout and the slides facilitation notes, as the regular teacher guide ("Teacher Instructions" tab online) does not include enough facilitation to ensure student-driven instruction. Related evidence includes:

- The Family Outreach Letter includes the driving questions for each of the module's three lessons as well as a summary of what students will do in each lesson. If students read these resources before they have a chance to ask questions themselves, they are unlikely to feel as if they are driving the learning. Similarly, the targeted standards for the module are shown as a side tab in the student online edition, so some of the questions in the module would be answered right away (those that are answered by the Disciplinary Core Ideas (DCIs) directly).

- Vocabulary and Language Guide: "Students should be encouraged to frequently revisit their questions and answers, and connect them to their ongoing investigations to make sense of the Anchor Phenomenon. Note: This can be supported using the Phenomena Tracker routine detailed in the Making Sense of Phenomena document."
- Module Wonder Questions handout: The teacher is supported to elicit and refine student questions from their observations of phenomena (pages 1–2). The teacher is also told, "The Twig Questions are suggested teacher-facing versions of the Wonder Questions students are likely to generate. These questions are examples only. The teacher should incorporate and elevate students' own questions into slides and other student-facing materials to help students feel that their questions are driving their learning" (page 5). Specific suggestions are provided related to engaging students in the storyline for each session:
  - Lesson 1: "Session 1: To help students generate questions about how volcanoes change over time, prompt them to consider the dates of eruptions in the Volcano Headlines handout. Ask them to consider whether they think it is likely that these volcanoes erupted before the 1900s and whether they think these volcanoes are likely to erupt again. Session 2: Students watch a video describing the appearance of a new volcano in Mexico in 1943. This may lead students to think that a volcano could change over time. It may also give students some ideas about the signs that may indicate an approaching volcanic eruption. Note: Record any questions related to this, as this concept will be explored in Lesson 3. Once students identify that a landscape (including volcanoes) may change over time, prompt students to consider what evidence they might be able to see, hear, or feel that shows a landscape feature might be volcanic. Guide students to identify that there may be evidence of both changing and stable landscapes that is difficult to observe. This is important for helping students understand why modeling is an important tool for understanding changes in the landscape" (page 3).
  - Lesson 2: "During the Wonder Question routine in Lesson 1, students may ask questions about the level of threat posed by a volcano. However, they may not yet have ideas about how to quantify or measure the degree of threat from a volcano. As students progress through Lesson 2, support them in determining how they might be able to measure the threat posed by different hazards associated with volcanoes. This will be especially helpful for guiding students to understand how the Science and Engineering Practice of Analyzing and Interpreting Data and the Crosscutting Concept of Patterns are important for evaluating the risk of natural hazards. In Lesson 2, Sessions 1–3, students will use physical and digital models of volcanic eruptions, lava, and tephra to understand why volcanic eruptions differ in their explosivity. If students generate Wonder Questions regarding the behavior or composition of lava, prompt them to consider the different ways they could study lava in the classroom. Remind them that in Lesson 1, they developed and used models to understand processes or objects that were difficult to

observe. Encourage them to consider the role that models could play in helping them understand lava" (page 4).
    - Lesson 2: In the slide deck, teachers are reminded to reword the Wonder Question to reflect the language of the relevant student Wonder Questions (slide 10).
    - Lesson 3: "At the beginning of the module, students may struggle to come up with testable scientific questions related to keeping residents safe from volcanic activity. If students are having difficulty generating questions about monitoring volcanoes or protecting residents from volcanic activity, consider prompting them to think about another natural disaster they may be more familiar with….During Lesson 2, students learn about hazards that make volcanoes dangerous. Thus, students may be better prepared to craft specific scientific questions about protecting residents at the start of Lesson 3. Prompt students to consider what they learned about the dangers posed by volcanoes in their investigations of lava and their examination of the Mount St. Helens case study. Guide students to consider the evidence in the days and weeks prior to the Mount St. Helens eruption that signaled the volcano was about to erupt, and how that evidence was (or could be) monitored" (page 4).
    - As the guidance in this handout is not incorporated into or described as required for all classrooms in the teacher instructions, it is unlikely that they will be used in all classrooms.
- In the slide deck, each lesson begins and ends with some prompts for engaging students in driving instruction. Students are asked if they "have any new questions that could add to our understanding of the Anchor Phenomenon" (e.g., Lesson 2, slide 7). Students are then asked which question from the group they should try to answer first and "how might we answer this question?" (e.g., Lesson 2, slide 9). A slide facilitation note says, "You can rearrange the order of sessions to reflect student interest. Remember: You may need to modify the content to account for assumed prior knowledge if sessions are rearranged." Similar guidance is given at the end of the session: "Which question should we try to answer next?...How might we answer this question?" (e.g., Lesson 2, slide 18). However, these instructions are only visible in the slide deck, which is referenced in the online teacher instructions at the end of each lesson such that teachers might think its use is optional.
- Lesson 1, Session 1: "Use the Co-Craft Questions language routine to generate Wonder Questions about the Anchor Phenomenon. Have students work individually and then in small groups and record their questions on scratch paper. Prompt groups to share their Wonder Questions, and record them on the board. Have the class reframe the questions as investigable questions. Discuss ways of grouping questions together, and whether there are any missing questions. Based on the discussion, develop a physical or digital Class Wonder Questions chart." The teacher is then prompted to facilitate student conversation such that the question groupings will include those that match the foci of the three lessons in the module. The slide deck provides prompts for students to use in grouping, such as "Are there any connections between the questions?...Think about whether you need answers to one question before you can answer another." The slide facilitation notes say, "Guide students to group questions that consider: How and why an area might change as a result of geoscience processes associated

with volcanic activity, and how volcanoes could be recognized in the landscape (Lesson 1). What makes volcanoes dangerous to human populations (Lesson 2). How we can predict eruptions and protect communities from the risks they pose (Lesson 3)" (slide 14).

- Lesson 1, Session 1: The class watches and discusses a video and the slide facilitation notes say, "Look/listen for responses that indicate a community could better predict or plan for future hazards by understanding a volcano. Use talk moves to prompt students to add detail to their own and one another's answers" (slide 18).
- Lesson 1, Session 1: In the Exit Ticket directions, the teacher is told to "Use students' ideas to prompt and extend student discussion in the next session and throughout the module." Suggestions or examples for how to do this are not included.
- Lesson 1, Session 1: A teacher sidebar note says, "At the start of each session, display the Class Wonder Questions chart and highlight the Wonder Questions that students will be exploring today." This note is repeated at the beginning of each session. However, facilitation notes are not often provided to help ensure that students feel as if their questions are the reason the next activity will take place. The teacher might therefore just point to questions and say, "these are the questions we will explore today."
- At the beginning of most sessions, the teacher is told, "After students have reflected on the previous session, engage in the Wonder Question routine by displaying the Class Wonder Questions chart and highlighting the Wonder Questions that students will be exploring today." This instruction is repeated at the beginning of each session.
- Lesson 1, Session 3: "Remind students that they observed a volcano appear on a landscape in the Birth of a Volcano video in Session 2. Prompt students to consider that the video showed the 'birth' of a volcano but not the full 'lifetime' of the volcano, which they will observe in this session." Students watch a video about the life cycle of volcanoes, and the teacher is told to "Ask students to think about what questions they have about shield volcanoes after watching the video…Add new questions and wonderings to the Class Wonder Questions chart." Later, the teacher is told to "Divide the class into teams of four and point out the eight stations set up around the room. Explain that there are four separate activities, and that at each station, students will gather evidence to help them figure out what causes a volcano to change over time." Suggestions are not given for how to help students gather this information, so it is likely that the station activity will seem heavily teacher driven.
- Lesson 1, Session 6: The activity is teacher directed without facilitating students to want to gather information through reading. "Ask students to look over the graphic organizer on pages 44–45 in their Twig Journals. Explain that their goal is to understand where different rocks originate and articulate how high temperature, pressure, and environmental forces shape materials. Prompt them to think about how the role of energy transfer and cycling of matter occurs in the rock cycle. Have students read the 'What's in a Rock?' article on pages 38–43 in their Twig Journals about how rocks form. Encourage them to fill out the graphic organizer."
- Lesson 1, Session 7: The session starts with a recall activity (students put a story in order from memory and then revise their work by watching the story again) without connecting to student questions or to sense-making. The teacher is then told to "Review any questions the students came up with when first learning about the shield volcano in Session 3. If students were not able

to answer those questions in Session 3, remind them of these questions now and inform them that they will explore another example of a volcano changing over time. Encourage students to look for answers to these questions as they learn about Mount Mazama." Suggestions are not provided for facilitating students to want to read in order to answer their questions.

- Lesson 1, Session 8: Students revisit an investigative phenomenon from a prior lesson (there are no reported eruptions in Kathmandu). They are asked, "Why do you think that is? What other evidence supports your claim? What other evidence could we gather?" Students are therefore supported to engage in driving the lesson, although specific guidance is not provided for the teacher to use elicited student ideas to facilitate the introduction to the next activity.
- Lesson 1, Session 8: Students watch a video, and the teacher is told, "Share that students will learn more about the study volcano, as well as the dangers posed by volcanoes, in Lesson 2." Student questions or motivation to learn about the study volcano or the dangers of volcanoes are not elicited.
- Lesson 1, Session 8: Students are asked how they might investigate whether there are any volcanoes near them now or if there were in the past (slide 129).
- Lesson 2, Session 3: "Remind students that they have been using models to investigate the different ways that lava behaves in a volcanic eruption. Let them know that they will continue to model lava today. Arrange students into teams and give each team three straws. Explain that three members from each team will use the straws to test three different liquids." The activity is solely teacher directed. Although the slide 34 asks students to think about how to answer the question "why do some volcanoes explode?" guidance is not provided to help teachers facilitate and elicit student responses that would result in modeling lava.
- Lesson 2, Session 4: The lesson begins by referring to student questions that will be answered, and then an instruction to the teacher "Explain that students each have 15 cards with data about different eruptions around the world. Have them play Extreme Eruptions." Students therefore might notice the investigative phenomenon but are not prompted to ask questions about it. Although in the slide deck, students are asked, "What do we already know that can help us answer this question? How might we answer this question?" (slide 49) guidance is not provided to help teachers facilitate and elicit student responses that would result in playing a game.
- Lesson 2, Session 5: Students watch a video about Mount St. Helens, ask questions about it, and then "read an article and gather evidence about the eruption of Mount St. Helens and what makes it dangerous." It is not clear that the reading will answer students' questions, as the directions for eliciting questions do not include facilitation prompts for ensuring questions will be elicited that will be answered by the reading.
- Lesson 3, Session 1: Students are asked to generate questions and are asked, "which question should we try to answer first? How might we answer this question?" (slide 9). In the slide presenter notes, the teacher is told, "you can rearrange the order of sessions to reflect student interest." However, no guidance is provided to link student ideas to the activity. The teacher is next told to "Explain that, today, students will gather, analyze, and interpret volcanic data for a fictional volcano." At the end of the lesson, the teacher is told to "Prompt students to consider how these findings relate to their remaining Wonder Questions."

- Lesson 3, Session 2: Students are engaged in a discussion about the importance of collecting data and how they think volcanologists collect data. The class then watches a video about "the volcanology team explaining some of their monitoring devices and techniques." Watching the video is therefore somewhat motivated (from the perspective of the students) by student conversation. The teacher is told to "Ask students to think about what new questions or wonderings they have about volcanoes after watching the video. Allow students to share their questions with a partner, then share and synthesize as a class. Add new questions or wonderings to the Class Wonder Questions chart."
- Lesson 3, Session 3: "Is there any other information or data that you think would be important to consider? Note: If needed, prompt students to reflect on the 'Different Volcanoes, Different Eruptions' article." The sample student response is "I think scientists should consider historic data too. Knowing about past eruptions could help them make predictions about future ones." The class then looks at historical data from a volcano, so student ideas are used to drive learning.
- Lesson 3, Session 4: Students observe an investigative phenomenon about a volcano that erupted even though its "activity didn't seem to indicate that an eruption was imminent." Students are asked, "What does this situation tell you about warning levels and eruptions?" Sample student answers include "Maybe we need more data to understand the volcano's eruptive behavior. Maybe we need to do more research about that kind of volcano." Students therefore are expected to generate motivation to drive the next session, which looks at volcanoes that might warrant more monitoring because they might erupt.
- Lesson 3, Session 5: "Ask students to think about what new questions or wonderings they have about monitoring volcanoes after watching the video. Allow students to share their questions with a partner, then share and synthesize as a class. Add new questions or wonderings to the Class Wonder Questions chart." Prompts are not provided, however, to connect these questions to the next activity.
- Lesson 3, Session 6: Students are asked, "which questions have we looked at so far? Can we fully answer them? What do we still have to explore?" The slide facilitation notes say, "You may wish to allow students additional time to extend their explorations to address any outstanding questions. Alternatively, preview future modules, and identify where these questions may be addressed. Store the student questions and return to them during these modules where appropriate" (slide 91). Student questions are therefore respected.

Students are asked to recall prior knowledge in a couple of cases to aid their sense-making:

- Lesson 1, Session 4: "Have students recall the four major Earth systems from Grade 5. 'What is the Earth system that includes rocks, magma, soil, and sediment?'…'What other systems are interacting with the geosphere in the processes of weathering and erosion? How are they interacting?'" "Ask students whether they think the model currently captures all of these interactions and processes. Students will likely claim that their models are incomplete."
- Lesson 1, Session 6: Students are asked, "Can you think of other natural processes that involve the flow of energy and cycling of matter?"

- Lesson 3, Session 2: "Ask students to discuss what they know about the events that precede local natural hazards, such as extreme weather, earthquakes, tsunamis, or wildfire. Encourage them to share ideas about the kinds of data that scientists might collect in order to forecast these hazards."

Suggestions for Improvement

- Rewording the Family Outreach Letter or waiting to send it home until after the class develops the driving questions would be helpful in supporting student agency in the progression of instruction in this module.
- Consider including the critical pieces of student facilitation directly in the teacher instructions rather than only in the slide deck, such as asking students how they might answer the focal questions.
- In the "Interpretation" sections of the slide facilitation notes (e.g., Lesson 1, slide 76), consider providing teachers with guidance to look/listen for student ideas that connect to the next activity and to highlight those ideas. This would help students feel as if they are driving the learning.

I.B. THREE DIMENSIONS

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.

i. Provides opportunities to *develop and use* specific elements of the SEP(s).
ii. Provides opportunities to *develop and use* specific elements of the DCI(s).
iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

Rating for Criterion I.B. Three Dimensions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Students are supported to use and develop many grade-appropriate elements of all three dimensions. However, there is a mismatch between some claims and evidence of student use of SEP elements.

The Performance Expectation Progressions document describes expectations for each lesson and lesson session for which parts of claimed elements are used and distinguishes between lesson sessions in which students are "working toward mastery" and lesson sessions in which students are "demonstrating mastery." For example, the document lists "SEP-4.M4" as "Working Toward Mastery" in Lesson 2, Session 3 and "Demonstrating Mastery" in Lesson 2, Session 6 (page 13). Note that each lesson itself only lists full elements rather than designating partial elements or differentiating between elements that students are only working toward versus fully demonstrating mastery. Therefore, it is likely that busy teachers will miss the specificity given in the Performance Expectation Progressions document.

Teachers are given a "Support Guide for the Science and Engineering Practices and Crosscutting Concepts," which lists which SEP and CCC supports are recommended for each session in the module. For example, in Lesson 1, Session 4, the following supports are recommended: "Developing and Using Models: Think About, Sentence Frames, Graphic Organizer MOD-3. Energy and Matter: Think About, Sentence Frames, Graphic Organizer EM-1" (page 2).

Although color coding seems to designate parts of each of the three dimensions that are involved in lesson-level learning targets, this color coding might not be apparent to all audiences or busy teachers, and the connections to specific elements of each dimension are sometimes unclear. For example, in Lesson 1, Session 1, the second objective has the following parsed phrase highlighted in blue: "Use observations." However, none of the seven SEPs is named "observation." This phrase seems to match the **Planning and Carrying Out Investigations** element "*Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution*," but this match is unclear since "make" and "use" are quite different, and SEP 3 is not the focus of the session. Thus, it is potentially confusing for teachers to make sense of what they are supposed to teach in terms of three dimensions.

Science and Engineering Practices (SEPs) | Rating: Adequate

The reviewers found adequate evidence that students have the opportunity to use the SEPs in this unit. Students are supported to use many grade-appropriate SEP elements and to develop new understanding of several grade-appropriate SEP elements. However, there is a mismatch between some claims and evidence of student use of those elements.

Handouts are provided to help students develop proficiency in several elements of each of the claimed SEPs and are referred to several times during the module. For example, in Lesson 3, Session 5: "Refer to the Volcano Hunters SEP and CCC Support Guide for suggestions on supporting student understanding of the Obtaining, Evaluating, and Communicating Information element using the Obtaining, Evaluating, and Communicating Information handout."

Asking Questions and Defining Problems

- Non-Focal Element: *Ask Questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information.*
    - Lesson 1, Session 1: This element is fully claimed as an opportunity for students to work toward mastery. An **Asking Questions and Defining Problems** handout is described as an optional digital resource to use. "Use the Co-Craft Questions language routine to generate Wonder Questions about the Anchor Phenomenon. Have students work individually and then in small groups and record their questions on scratch paper. Prompt groups to share their Wonder Questions, and record them on the board. Have the class reframe the questions as investigable questions."

- Lesson 2, Session 1: This element is fully claimed as an opportunity for students to work toward mastery. The teacher is told to “Explain that students can share and add any new questions they have as they work through the module to their Wonder Questions charts on pages 4-5 in their Twig Journals.” It is not clear that all students will ask questions in this session.
- Lesson 3, Session 1: This element is fully claimed as an opportunity for students to work toward mastery. The teacher is told to “Explain that students can share and add any new questions they have as they work through the module to their Wonder Questions charts on pages 4–5 in their Twig Journals.” It is not clear that all students will ask questions in this session.

Developing and Using Models

- Focal Element: *Develop and/or use a model to predict and/or describe phenomena.*
    - Lesson 1, Session 1: This element is not claimed. An Optional **Developing and Using Models** handout is linked. In the pre-assessment, students are asked to use a model to make a prediction.
    - Lesson 1, Session 4: This element is partially claimed (not the predict part) as an opportunity for students to work toward mastery. Students use crayons to develop models of different kinds of rock formations and discuss how their models do and do not represent real rocks. A student response says, “The models show the types of energy flows and processes that might form real rocks, like how pressure or energy from the inside of the Earth could cause a rock to melt or look squished together.”
    - Lesson 1, Session 5: This element is partially claimed (not the predict part) as an opportunity for students to work toward mastery. At the end of the session students are asked to “Revisit the landscape model. Update and use your model to describe the processes that caused the observable changes in the landscape. Be sure to include the source(s) and flow of energy and the movement of matter.”
    - Lesson 1, Session 7: This element is partially claimed (not the predict part) as an opportunity for students to demonstrate mastery. “Ask students to turn to page 53 in their Twig Journals to draw a diagram that illustrates the steps that occurred at the plate boundary during Phase 1 of Mount Mazama’s creation. Encourage students to add labels and use arrows to demonstrate how the materials cycle through the landscape.”
    - Lesson 1, Session 8: This element is partially claimed (not the predict part) as an opportunity for students to demonstrate mastery. In the summative assessment, the “proficient” level of student performance in the rubric says, “Student constructs explanations of stability and change in a landscape by using the model to describe the changes to rocks over time and the processes that result in these changes at different scales, including the atomic scale” (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5).

Planning and Carrying Out Investigations

- Non-focal element: *Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions.*
    - Lesson 2, Session 2: This element is fully claimed as an opportunity for students to demonstrate mastery. Students follow given steps to collect data to answer the question "what effect do you think the slope and lava thickness would have on the behavior or lava during an eruption?"
    - Lesson 2, Session 3: This element is fully claimed as an opportunity for students to demonstrate mastery. Students use a digital interactive and record their observations, but they are not focused on collecting evidence to answer scientific questions or to test design solutions (although afterward they are asked to use their observations as evidence). They are instead asked to complete digital challenges and to fill out a given data table.

Analyzing and Interpreting Data

- Non-focal element: *Use graphical displays (e.g., maps, charts, graphs, and/or tables) of large data sets to identify temporal and spatial relationships.*
    - Lesson 3, Session 1: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students are asked, "Do you see any patterns in the data values and whether the volcano was erupting? Provide evidence." "How could identifying these patterns be useful to scientists?" Note that the data sets are not large.
    - Lesson 3, Session 3: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students graph and then interpret data, although the data sets are not large. Students analyze and interpret data and are asked to "discuss what types of readings demonstrate increasing volcanic activity," so students are more likely to use the unclaimed element *Analyze and interpret data to provide evidence to provide evidence for phenomena*.
- Non-focal element: *Analyze and interpret data to provide evidence for phenomena.*
    - Lesson 2, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Students use a digital interactive activity and record their observations, and then are prompted to answer the question "What is the relationship between viscosity, gas content, and explosivity? Use evidence to justify your answer."
    - Lesson 2, Session 6: This element is fully claimed as an opportunity for students to demonstrate mastery. Students are asked to "Analyze and interpret the data in the Dangers of Volcanoes handout and on pages 65-66, 67, and 75. Use the patterns that you notice as evidence to support an argument that some volcanoes present a greater hazard than others."
- Focal Element: *Analyze and interpret data to determine similarities and differences in findings*.
    - Lesson 2, Session 3: This element is partially claimed (not the similarities part) as an opportunity for students to work toward mastery. Students use a digital interactive activity and record their observations using differing conditions for the simulation. They

are prompted to answer the question "What is the relationship between viscosity, gas content, and explosivity? Use evidence to justify your answer."

- Lesson 2, Session 4: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked to read a text that includes data tables, and to "record similarities or differences in height, VEI, eruption or volcano types, and population size."
- Lesson 2, Session 6: This element is fully claimed as an opportunity for students to demonstrate mastery. Students are asked to "Analyze and interpret the data in the Dangers of Volcanoes handout and on pages 65-66, 67, and 75. Use the patterns that you notice as evidence to support an argument that some volcanoes present a greater hazard than others."
- Lesson 3, Session 1: This element is partially claimed (not the similarities part) as an opportunity for students to work toward mastery. The teacher is told to "Challenge students to identify which techniques they are going to use to analyze the data, and why. Provide blank chart paper and encourage them to create graphs." "Have teams analyze the similarities and differences in their data, looking for patterns and considering what different monitors showed when the volcano was erupting."
- Lesson 3, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Students graph and then analyze data and are asked, "Are there two or more data types that follow the same trend or pattern? What could this mean?" The sample student response says, "It could mean that both data types are connected to each other. If one reading increases, it affects another in the same way." Teachers are told to "provide feedback on the students' analysis and interpretation of the data (including their identification of similarities and differences between data from different sources), and their use of their graphs as evidence to support their answers."
- Lesson 3, Session 4: This element is fully claimed as an opportunity for students to demonstrate mastery. Students are asked, "What evidence in the [two months before] dataset tells you this volcano requires a [Watch] warning?" The sample student answer says, "The data has high values, and there are some overlapping peaks between data types. But the values aren't as high as they are in the [ten days before] dataset, when an eruption is about to happen." The teacher is told to "Look/listen for responses that include rationale describing patterns in the data. Prompt students for more detail on similarities and differences in the data that prompted them to assign a particular data period to a particular warning level."
- Lesson 3, Session 5: This element is fully claimed as an opportunity for students to demonstrate mastery. Students do a first draft of their summative assessment task, which asks them to "provide rationale using similarities and differences in the data as evidence."

Constructing Explanations and Designing Solutions

- Non-focal element: *Construct an explanation using models or representations.*
    - Lesson 1 Session 8: This element is fully claimed as an opportunity for students to work toward mastery. Students are given a CER chart and, in the summative assessment, the proficient level of the rubric says, "Student constructs explanations of stability and change in a landscape by using the model to describe the changes to rocks over time and the processes that result in these changes at different scales, including the atomic scale" (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5). Note, however, that little session-specific support is given for using the CER chart, so it is unlikely that all classes would use it as intended.
- Non-focal element: *Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.*
    - Lesson 2, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "Based on your ideas from the video and the reading, how might scientists' understanding of geologic forces have helped them forecast that Mount St. Helens was about to erupt?" The sample student answer says, "The series of earthquakes, the steam coming out of the mountain, and the landslide right before the eruption could all provide evidence that there was activity deep in the Earth." Students therefore identify evidence that is based on the assumption that the natural world operates today as it did in the past and will continue to do so in the future.
    - Lesson 3, Session 3: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "How can an understanding of geologic forces help scientists forecast the likelihood or location of a future eruption? Provide an example." The sample student answer says, "By understanding the geologic events that lead up to a volcano, scientists can make predictions about future eruptions. For example, if there are a lot of earthquakes in an area where there is a volcano, it means that there is movement underground, which could be caused by magma rising." Students explain the phenomenon that scientists can forecast the likelihood of something occurring in the future using the assumption that the natural world operates today as it did in the past and will continue to do so in the future.
    - Lesson 3, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "Why should the volcano you selected be high priority for monitoring? Include information about at least four of these factors: Current activity status, Type of volcano, Local populations, Eruptive history, VEI. Provide rationale using similarities and differences in the data as evidence." Students are not asked to explain a phenomenon in this activity, so there is no evidence that they use the claimed element.

- *Apply scientific ideas or principles to design, construct, and/or test a design of an object, tool, process or system.*
    - Lesson 3, Session 5: This element is not claimed but is partially used when students draft their volcano monitoring plans.

Engaging in Argument from Evidence

- Non-focal element: *Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.*
    - Lesson 1, Session 7: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. "Ask students to pair up to verbally share their thinking, referring to any visuals as needed. As Student 1 shares, Student 2 should listen carefully and ask for clarity, reasoning, details, and examples that support Student 1's thinking. Students then switch roles."
- Non-focal element: *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.*
    - Lesson 2, Session 6: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. The teacher supports students to develop toward this element: "Pick a piece of evidence. Have students evaluate whether the evidence makes sense in addressing the claim. Use a think-aloud to go over and interpret the evidence. Then, provide a piece of reasoning for the analyzed piece of evidence. Have students evaluate and support why the reasoning is strong, and then practice this skill independently." Later in the session, students are asked to argue from evidence, to "collect evidence and develop reasoning to support the claim: Some volcanoes are more dangerous than others. Use resources from previous sessions and note the sources of your evidence."
    - Lesson 3, Session 4: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked, "What can we say about data and increased volcanic activity?" The sample student answer says, "When there is increased volcanic activity, the data shows higher values, larger peaks, and a greater number of overlapping peaks." Students are then asked, "How does the historic data support your decision?" The sample student answer says, "We learned from the historic data that [gas levels] are around [number] at [time before eruption]. The patterns in the historic data at [time before eruption] looked similar to [time stamp] in the current dataset. This helped us estimate from the current data how far away a potential eruption might be."
    - Lesson 3, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "Why should the volcano you selected be high priority for monitoring? Include information about at least four of these factors: Current activity status, Type of volcano, Local populations, Eruptive history, VEI. Provide rationale using similarities and differences in the data as evidence."

Obtaining, Evaluating, and Communicating Information

- Non-focal element: *Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.*
  - Lesson 1, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Students jigsaw various readings, activities, and simulations, and then share information with each other. They are then asked to use the combined information in sense-making.
- Non-focal element: *Communicate scientific and/or technical information (e.g., about a proposed object, tool, process, system) in writing and/or through oral presentations.*
  - Lesson 1, Session 2: This element is fully claimed as an opportunity for students to work toward mastery. Students read informational text and then respond to the question "Where are volcanoes found? Write an explanation using evidence gathered from the 'At the Plate Boundaries' article and the Volcano Explorer digital interactive." The sample student answer shows information communication, matching the SEP claim for this session. However, note that the prompt to "construct explanations" (meaning in this case "communicate information") may be confusing for teachers and students who expect the phrase to refer to the **Constructing Explanations** SEP.
  - Lesson 1, Session 6: This element is fully claimed as an opportunity for students to work toward mastery. After reading an informational text, students are asked to "describe how the rocks are created."
  - Lesson 1, Session 7: This element is fully claimed as an opportunity for students to work toward mastery. Students write a response to "How did Mount Mazama change over its lifetime?...Explain the processes involved." Students also discuss their thinking with peers orally.
  - Lesson 2, Session 4: This element is fully claimed as an opportunity for students to work toward mastery. "Students discuss some features that make volcanoes dangerous." They also write a paragraph about which volcano is likely to be more dangerous and why.
  - Lesson 3, Session 2: This element is fully claimed as an opportunity for students to work toward mastery. Students respond to the following prompt in writing and then discuss their answers with partners. "Write your initial response to the discussion prompt: What knowledge and tools can scientists use to forecast the locations and likelihood of volcanic eruptions? Use evidence to justify your answer."
  - Lesson 3, Session 5: This element is fully claimed as an opportunity for students to work toward mastery. Students write out their volcano monitoring plans.

Disciplinary Core Ideas (DCIs) | **Rating: Extensive**

The reviewers found extensive evidence that students have the opportunity to use or develop the DCIs in this unit. Students are well-supported to develop understanding of the focal elements in the module, and there is a close match of claims and evidence of student use of the elements.

ESS2.A Earth's Materials and Systems

- Focal Element: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
    - Lesson 1, Session 3: This element is partially claimed (not the "within and among the planet's systems" and "living organisms" parts) as an opportunity for students to work toward mastery. Students read about Earth's hot interior and about the effects on plate movement.
    - Lesson 1, Session 4: This element is partially claimed (not the last sentence) as an opportunity for students to work toward mastery. Students are asked, "How do the models relate to real rocks?" An example student answer says, "The models show the types of energy flows and processes that might form real rocks, like how pressure or energy from the inside of the Earth could cause a rock to melt or look squished together."
    - Lesson 1, Session 5: This element is partially claimed (not the "chemical and physical" and "living organisms" parts of the last sentence) as an opportunity for students to work toward mastery. Students play a game to learn about rock cycles, discussing energy transfers that affect the rock cycle. In addition, at least one of the paragraphs associated with the rock journey activity contains many of the ideas from the element.
    - Lesson 1, Session 6: This element is partially claimed (not the "among" the planet's systems part) as an opportunity for students to demonstrate mastery. The teacher is told, "As students read the text and complete the graphic organizer, they should consider how energy transfers from the Sun and matter cycles in the Earth's hot interior drive the transformations of the rock cycle."
    - Lesson 1, Session 7: This element is partially claimed (not the "energy flowing", "the sun", or "chemical changes" parts) as an opportunity for students to demonstrate mastery. Students discuss matter cycling (rock cycles) involved in the formation and changes of a mountain.
    - Lesson 1, Session 8: This element is mostly claimed (except the "living organisms" part) as an opportunity for students to demonstrate mastery. In the summative assessment in this session, the proficient level of the rubric says, "Student identifies that the process of chemical and physical change in a landscape is a result of energy flowing and matter cycling within and among the Earth's systems. Student describes that this energy is derived from the Sun and the Earth's hot interior" (Hills and Mountains, or Volcanoes? Teacher Rubric, page 5).

    - A note in the Performance Expectation Progressions document states that "Energy flows within living organisms is [sic] mastered in the Future Food module. Energy flows within the atmosphere and hydrosphere are mastered in the [sic] The Great Air Race and Model Earth modules" (page 6).
- Non-focal element: *The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future.*
    - Lesson 1, Session 3: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students read about different ways volcanoes change over time, including at the molecular scale.
    - Lesson 1, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students learn about the rock cycle, including general ideas of time scales involved.
    - Lesson 1, Session 7: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students discuss time scales involved in a mountain's formation and the changes over its lifetime.

ESS3.B Natural Hazards

- Focal Element: *Mapping the history of natural hazards in a region, combined with an understanding of related geologic forces, can help forecast the locations and likelihoods of future events.*
    - Lesson 2, Session 4: This element is partially claimed (not the "mapping" part) as an opportunity for students to work toward mastery. Students complete a reading and are asked, "How might understanding the history of eruptions in a region help scientists in that community forecast the likelihood or location of future events?" The sample student answer says, "Having an idea of what happened in the past could give them an idea of what could happen in the future. For example, scientists know from previous eruptions that Hawaiian eruptions have effusive magma so they aren't very explosive."
    - Lesson 2, Session 5: This element is partially claimed (not the "mapping" and "locations" parts) as an opportunity for students to work toward mastery. Students read a text and are asked, "What might present-day scientists monitoring Mount St. Helens need to consider as they work to forecast the likelihood of future eruptions?" The sample student answer says, "They should consider all of the things that scientists learned from the eruption in 1980, like the fact that it was a lateral blast."
    - Lesson 2, Session 6: This element is partially claimed (only the middle part: "An understanding of related geologic forces can help forecast the likelihoods of future events") as an opportunity for students to demonstrate mastery. Students construct arguments about patterns in volcanoes that allow them to predict that some volcanoes present a greater hazard than others.
    - Lesson 3, Session 2: This element is partially claimed (not the "mapping" and "locations" parts) as an opportunity for students to work toward mastery. Students discuss the importance of collecting data about volcanoes in order to be able to predict eruptions.

- Lesson 3, Session 3: This element is partially claimed (not the mapping and locations parts) as an opportunity for students to work toward mastery. Students are asked, "How can an understanding of geologic forces help scientists forecast the likelihood or location of a future eruption? Provide an example." The sample student answer says, "By understanding the geologic events that lead up to a volcano, scientists can make predictions about future eruptions. For example, if there are a lot of earthquakes in an area where there is a volcano, it means that there is movement underground, which could be caused by magma rising."
- Lesson 3, Session 4: This element is partially claimed (only the middle part: An understanding of related geologic forces can help forecast the likelihoods of future events) as an opportunity for students to demonstrate mastery. The proficient level of the scoring rubric for the assessment task in the session lists the full element as something students need to identify. Students are also asked, "How does the historic data support your decision?" The sample student answer says, "We learned from the historic data that [gas levels] are around [number] at [time before eruption]. The patterns in the historic data at [time before eruption] looked similar to [time stamp] in the current dataset. This helped us estimate from the current data how far away a potential eruption might be."
- Lesson 3, Session 5: This element is fully claimed as an opportunity for students to demonstrate mastery. Students are asked, "Why should the volcano you selected be high priority for monitoring? Include information about at least four of these factors: Current activity status, Type of volcano, Local populations, Eruptive history, VEI. Provide rationale using similarities and differences in the data as evidence."

PS1.A Structure and Properties of Matter

- Non-focal element: *Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.*
  - Lesson 2, Session 1: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students observe different chemical reactions, but they don't discuss the nature of the chemical reactions or any part of this DCI element.
  - Lesson 2, Session 2: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students make observations and discuss to "connect how different properties affect lava's behavior."

Crosscutting Concepts (CCCs) | **Rating: Extensive**

The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit. Students have many opportunities to use grade-appropriate CCC elements in the unit and are supported to develop new understanding of CCC elements. There is also a close match between claims and evidence of student use of the CCC elements.

Handouts are provided to help students develop proficiency in several elements of each of the focal CCCs and are referred to several times during the module. For example, in Lesson 3, Session 4: "Refer to the Volcano Hunters SEP and CCC Support Guide for suggestions on supporting student understanding of the Stability and Change element using the Stability and Change handout."

Patterns

- Grade 3–5-level element: *Patterns of change can be used to make predictions.*
    - Lesson 3, Session 2: This element is not claimed but students are expected to demonstrate it. The teacher is told to "Look/listen for responses indicating students are applying ideas about patterns in data that can be used to predict eruptions. Use talk moves to prompt students to add detail to their own and other students' ideas about other data that scientists might collect to generate predictions." This is a good example of applying students' prior knowledge.
- Non-focal element: *Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.*
    - Lesson 1, Session 7: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students determine patterns in rates of change, but do not discuss this element explicitly.
    - Lesson 2, Session 2: This element is fully claimed as an opportunity for students to work toward mastery. Students collect data about rates at which syrup flows down slopes of different steepnesses and create a chart that reveals a pattern.
    - Lesson 3, Session 1: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked, "Do you see any patterns in the data values and whether the volcano was erupting? Provide evidence." A sample student answer says, "Usually data values would be high when the volcano was erupting. For example, the GPS receiver recorded 0–4 mm of ground movement when the volcano was not erupting, but 4–8 mm when it was erupting."
    - Lesson 3, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked, "Are there any times that several data types (seismic, temperature, GPS, and/or gas) peak at the same time? What might this suggest?" The sample student answers say, "Because lots of data is peaking at the same time, an eruption could be approaching" and "There isn't much overlap between the peaks in different data. The peaks seem kind of random, so an eruption is not likely to happen immediately."
- Focal Element: *Graphs, charts, and images can be used to identify patterns in data.*
    - Lesson 1, Session 2: This element is not claimed but is partially used. Students view images of the locations of volcanos around the world in the Volcano Explorer digital interactive. They are then asked, "Where are most of these volcanoes located? Why could that be?"
    - Lesson 2, Session 2: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to work toward mastery. Students collect data

about rates at which syrup flows down slopes of different steepnesses and create a chart that reveals a pattern.

- Lesson 2, Session 3: This element is partially claimed (not the "graphs" part) as an opportunity for students to work toward mastery. Students fill out a chart with their observations and then use the chart data as evidence to answer questions.
- Lesson 2, Session 4: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to work toward mastery. Students are given data in four very small charts and asked to respond to the question "Is there a relationship between the type of eruption and type of volcano."
- Lesson 2, Session 5: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to work toward mastery. Students create a t-chart of volcano physical hazards and impacts from volcanoes. However, they are not asked to identify or discuss patterns that arise from this chart (instead they create the chart with patterns they already knew).
- Lesson 2, Session 6: This element is partially claimed (not the "graphs" part) as an opportunity for students to demonstrate mastery. Students are asked to "Analyze and interpret the data in the Dangers of Volcanoes handout and on pages 65-66, 67, and 75. Use the patterns that you notice as evidence to support an argument."
- Lesson 3, Session 1: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to work toward mastery. Students are asked to graph data and then are asked, "Do you see any patterns in the data values and whether the volcano was erupting? Provide evidence."
- Lesson 3, Session 3: This element is partially claimed (not the "images" part) as an opportunity for students to work toward mastery. Students are given data and are asked, "What can we do to make it easier for us to look for patterns in this data?" The sample student answer says, "We can create graphs so the patterns in the data are easier to observe."
- Lesson 3, Session 4: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to demonstrate mastery. Students are presented with data in a chart, and are asked, "How does the historic data support your decision?" The sample student response says, "We learned from the historic data that [gas levels] are around [number] at [time before eruption]. The patterns in the historic data at [time before eruption] looked similar to [time stamp] in the current dataset. This helped us estimate from the current data how far away a potential eruption might be."
- Lesson 3, Session 5: This element is partially claimed (not the "graphs" and "images" parts) as an opportunity for students to demonstrate mastery. In the three-dimensional reflect, students are given a chart of data and are asked to "look for patterns in the data to identify the state likely to experience the least amount of damage and disruption caused by hurricanes."

Cause and Effect

- Non-focal element: *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
    - Lesson 2, Session 3: This element is fully claimed as an opportunity for students to demonstrate mastery. Expected student answers relate to cause and effect relationships, such as "There is a direct relationship between viscosity, gas content, and explosivity…..When magma has a high viscosity, or is very thick, gas can't move very easily—a lot of pressure can build up, and eventually this will result in an explosive eruption." Note that the CCC element is not explicit in this student performance, and that in the slide notes (slide 44) these ideas are instead listed as teacher prompts, as the teacher is told to summarize these concepts.

Scale, Proportion, and Quantity

- Non-focal element: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
    - Lesson 1, Session 4: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. After students model processes of rock formation, they are asked, "How well do the models represent the forces and processes that affect real rocks?" A suggested student answer says, "The models show the kinds of forces and processes that can affect real rocks, but the forces and processes in nature are bigger or stronger than what we can model in the classroom." In the Exit Ticket, students are asked, "Why are models important for understanding how rocks are formed?" A sample student answer says, "It is not easy to directly observe rock formation. Some of the processes might be too difficult to observe because they happen on a very small scale, little by little. Models allow scientists to observe things that are otherwise too difficult to observe directly."
    - Lesson 1, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "What do you think has happened to the rocks that used to be on the volcano in Image 3?...How has your model helped you make that claim?" The student-facing rubric lists a proficient level of performance as including the following: "Student mostly describes the role of the physical model in their description of the processes that cause observable changes in the landscape. Student mostly describes the role of the physical model in explaining the session's investigative phenomenon" (Different Types of Rocks Student Rubric, page 6).
    - Lesson 1, Session 6: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students demonstrate knowledge that phenomena happen at various scales and that some scales are hard to observe. The session Exit Ticket asks students "How can you use your model to explain why some landscape features appear to change while others appear to remain stable?"

- Non-focal element: *Phenomena that can be observed at one scale may not be observable at another scale.*
    - Lesson 1, Session 6: This element is fully claimed as an opportunity for students to demonstrate mastery. Students demonstrate knowledge that phenomena happen at various scales and that some scales are hard to observe. For example, students fill out a table with sample student answers such as: "At this scale [large time span], landscapes can appear to be stable…..At this scale [short time span], landscapes can appear to be changing."

Systems and System Models

- Non-focal element: *Models can be used to represent systems and their interactions — such as inputs, processes and outputs — and energy, matter, and information flows within systems.*
    - Lesson 1, Session 7: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students "draw the steps that occurred at the plate boundary during Phase 1 of Mount Mazama's formation. Use arrows to show how the materials are cycling." At the end of the session, students are asked to "Add labels to the model to show where they would find these rocks on the landscape….Describe the processes that would form igneous and sedimentary rocks at the location you labeled on the model." Note that energy is not included in the model labels, and neither the teacher materials nor the Twig Journal refers to a "system" being modeled.
    - Lesson 1, Session 8: This element is fully claimed as an opportunity for students to demonstrate mastery. In the summative assessment in this session, students use models and the proficient level of the rubric says, "Student identifies that the process of chemical and physical change in a landscape is a result of energy flowing and matter cycling within and among the Earth's systems" (Hills and Mountains, or Volcanoes? Teacher Rubric, page 5).

Energy and Matter

- Non-focal element: *Within a natural or designed system, the transfer of energy drives the motion and/or cycling of matter.*
    - Lesson 1, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked, "How are energy and forces involved?" A sample student answer says, "Energy is transferred to the mantle, melting it as it subducts."
    - Lesson 1, Session 4: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. Students explore different ways to change matter (crayons), including heating and cooling. Students are then asked to "Describe how energy was transferred during your modeling process."
    - Lesson 1, Session 5: This element is fully claimed as an opportunity for students to work toward mastery. Students study the rock cycle and the transfers of energy at each step.

  - Lesson 1, Session 6: This element is fully claimed as an opportunity for students to work toward mastery. Students read an article and are asked, "How is the flow of energy and cycling of matter connected to the rock cycle?"
  - Lesson 1, Session 8: This element is fully claimed as an opportunity for students to demonstrate mastery. In the summative assessment in this session, the proficient level of the rubric says, "Student identifies that the process of chemical and physical change in a landscape is a result of energy flowing and matter cycling within and among the Earth's systems. Student describes that this energy is derived from the Sun and the Earth's hot interior" (Hills and Mountains, or Volcanoes? Teacher Rubric, page 5).
- Non-focal element: *The transfer of energy can be tracked as energy flows through a designed or natural system.*
  - Lesson 1, Session 5: This element is fully claimed as an opportunity for students to work toward mastery. Students study the rock cycle and the transfers of energy at each step.

Stability and Change

- Focal Element: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - Lesson 1, Session 3: This element is partially claimed (not the "designed systems" or "atomic scale" parts) as an opportunity for students to work toward mastery. Students read about different aspects of how volcanoes change over time, including through chemical changes (e.g., both macroscopic and molecular scales).
  - Lesson 1, Session 5: This element is partially claimed (not the "designed systems" or "atomic scale" parts) as an opportunity for students to work toward mastery. Students study the rock cycle and are asked to describe it in a model. They might therefore begin to build toward this element.
  - Lesson 1, Session 6: This element is partially claimed (not the "designed systems" part) as an opportunity for students to demonstrate mastery. Students are asked, "how do the size and time span of a geologic process relate to its observability? How does observability affect how we understand stability and change in the landscape?" The teacher is told, "At this point in the lesson, students should be identifying that matter and processes can appear to change or be stable at the atomic scale. If students are only considering stability and change at the landscape scale, prompt them to refer back to examples in the text of changes that happen to particles, atoms, or crystals of rocks."
  - Lesson 1, Session 7: This element is partially claimed (not the "processes at different scales" part) as an opportunity for students to demonstrate mastery. Students are asked, "How did Mount Mazama change over its lifetime, When was it relatively stable? Explain the processes involved and whether the changes were fast or slow."
  - Lesson 1, Session 8: This element is partially claimed (not the "designed systems" part) as an opportunity for students to demonstrate mastery. In the summative assessment in this session, the proficient level of the rubric says, "Student constructs explanations of stability and change in a landscape by using the model to describe the changes to rocks

over time and the processes that result in these changes at different scales, including the atomic scale" (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5).

  - Lesson 3, Session 4: This element is partially claimed (not the "designed systems" or "processes at different scales" part) as an opportunity for students to demonstrate mastery. Students are asked, "How did patterns of stability and change in the volcano data affect your choices of warning levels?" The sample student answer says, "When the volcano data stayed the same from one day to the next, this made me think that the volcano was not changing very quickly. When many types of data changed, that made me think the volcano was changing more quickly and I changed the warning level."
- Non-focal element: *Stability might be disturbed either by sudden events or gradual changes that accumulate over time.*
  - Lesson 1, Session 5: This element is fully claimed as an opportunity for students to work toward mastery. Students study the rock cycle, which includes both sudden events and gradual changes. They may therefore begin to build an understanding of this element.

Suggestions for Improvement

General

- Consider ensuring that all documents show the same learning goals, including which parts of which elements are included and to what extent.
- Consider helping teachers know and understand how instruction is meant to help students work toward mastery for the non-focal SEPs and CCCs.

Science and Engineering Practices

- Consider aligning claims and evidence of student use of SEP elements in the module.

Disciplinary Core Ideas

- None

Crosscutting Concepts

- Consider providing more opportunities for students to use CCC elements explicitly, in addition to the CCC-specific handouts.

Volcano Hunters

EQuIP RUBRIC FOR SCIENCE EVALUATION

I.C. INTEGRATING THE THREE DIMENSIONS

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and designing solutions to problems. Students have many opportunities throughout the module for multi-dimensional learning. However, often students' three-dimensional performances are not directly in service of sense-making.

Students have many opportunities in the module to integrate the three dimensions in service of sense-making. For example:

- Lesson 1, Session 3: Students read about different aspects of how volcanoes change over time, including through chemical changes. Students jigsaw various readings, activities, and simulations, and then share information with each other. They are then asked to use the combined information in sense-making. In this performance students use parts of the following elements:
  - SEP: *Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.*
  - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - DCI: *The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 1, Session 5: Students are asked, "What do you think has happened to the rocks that used to be on the volcano in Image 3?...How has your model helped you make that claim?" The student-facing rubric lists a proficient level of performance as including the following: "Student mostly describes the role of the physical model in their description of the processes that cause observable changes in the landscape. Student mostly describes the role of the physical model in explaining the session's investigative phenomenon" (Different Types of Rocks Student Rubric, page 6). In this performance students use parts of the following elements:
  - SEP: *Develop and/or use a model to predict and/or describe phenomena.*
  - CCC: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior.*

The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.

- Lesson 1, Session 6: Students demonstrate knowledge that phenomena happen at various scales and that some scales are hard to observe. The session Exit Ticket asks students "How can you use your model to explain why some landscape features appear to change while others appear to remain stable?" In this performance students use parts of the following elements:
  - SEP: *Develop and/or use a model to predict and/or describe phenomena.*
  - CCC: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 1, Session 7: Students are asked, "How did Mount Mazama change over its lifetime?. When was it relatively stable? Explain the processes involved and whether the changes were fast or slow." The teacher is told to "Ask students to pair up to verbally share their thinking, referring to any visuals as needed. As Student 1 shares, Student 2 should listen carefully and ask for clarity, reasoning, details, and examples that support Student 1's thinking. Students then switch roles." In this performance students use parts of the following elements:
  - SEP: *Respectfully provide and receive critiques about one's explanations, procedures, models and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.*
  - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 1, Session 8: In the summative assessment in this session, the proficient level of the rubric says, "Student constructs explanations of stability and change in a landscape by using the model to describe the changes to rocks over time and the processes that result in these changes at different scales, including the atomic scale" (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5). In this performance students use parts of the following elements:
  - SEP: *Construct an explanation using models or representations.*
  - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*

- Lesson 3, Session 3: Students are asked, "Are there any times that several data types (seismic, temperature, GPS, and/or gas) peak at the same time? What might this suggest?" The sample student answers say, "Because lots of data is peaking at the same time, an eruption could be approaching." and "There isn't much overlap between the peaks in different data. The peaks seem kind of random, so an eruption is not likely to happen immediately." In this performance students use parts of the following elements:
  - SEP: *Analyze and interpret data to determine similarities and differences in findings.*
  - CCC: *Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.*
  - DCI: *Understanding of related geologic force can help forecast the locations and likelihoods of future events.*

Students also have opportunities to use three dimensions without connecting to sense-making. For example, in Lesson 1, Session 5, students study the rock cycle, which includes both sudden events and gradual changes. They write about the steps. In this performance, students use parts of the following elements, but are not using them in service of sense-making:

- SEP: *Communicate scientific and/or technical information (e.g., about a proposed object, tool, process, system) in writing and/or through oral presentations.*
- CCC: *Stability might be disturbed either by sudden events or gradual changes that accumulate over time.*
- DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*

Suggestions for Improvement

Consider making students' integration of the three dimensions explicit to teachers, such that they know what to look for if students are authentically learning with all three dimensions versus just two or just one.

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that lessons fit together coherently to target a set of Performance Expectations (PEs). All sessions in the module are linked thematically, and sessions very frequently refer explicitly to work and learning in prior lessons. Students are also supported to build proficiency in both claimed NGSS PEs.

All lessons are thematically linked in the unit to volcanoes. In almost all sessions, explicit teacher moves are given that ask students to refer back to a previous activity or phenomenon.

- Lesson 1, Session 1: A teacher sidebar note says, "At the start of each session, display the Class Wonder Questions chart and highlight the Wonder Questions that students will be exploring today." There is a teacher reminder about doing this in most sessions. Students are also asked to add questions to the Wonder Questions chart toward the end of many lessons.
- Lesson 1, Session 3: "Have students reflect on their ideas so far about how rocks and volcanoes are formed. Prompt students to think about the volcano they examined or imagined at the beginning of Session 1 as they answer the questions. 'What new ideas do you have about how volcanoes are formed?'"…"After students have reflected on their ideas, engage in the Wonder Questions routine by displaying the Class Wonder Questions chart and highlighting the Wonder Questions that students will be exploring today."
- Lesson 1, Session 6: The teacher tab begins with "Students review their observations about the rock samples and think about how each sample may have formed."
- Lesson 2, Session 1: "Ask students to recall the four locations they were investigating in Lesson 1. Optional: Prompt them to look at the images on pages 8–10 in their Twig Journals." Students then look at a new investigative phenomenon related to one of those four locations. However, students are then asked to watch a video and discuss how different volcanoes look different. The transition from danger to people in one location to physical characteristics of different volcanoes is not made immediately clear to students.

- Lesson 2, Session 2: The lesson begins by referring back to the activity from Session 1, turning it into a phenomenon about which students could have curiosity.
- Lesson 2, Session 6: The session begins with a reference to the first four volcano locations discussed in Lesson 1. "Remind them that the volcanology team is studying Bagana, a volcano on Bougainville Island (Location 2), What questions could you ask the volcanology team to determine how dangerous their volcano is?...How do these questions help you understand how dangerous the study volcano is?"
- Lesson 3, Session 2: The lesson begins by referring back to the activity from Session 1 (gathering data from videos). "Remind students of the videos from the previous session."
- Lesson 3, Session 4: Students use the data set from the previous session to assign warning labels.
- Lesson 3, Session 5: At the beginning of the session, the teacher is told to "Review that students have been learning about monitoring techniques. How does data help us monitor volcanoes?" The sample student answer says, "It helps us determine if and when an eruption is likely to occur." Additional questions then lead into the day's activity.

The following PEs are claimed in the unit. The Standards page says, "Students are either partially or fully using the following elements." See related evidence for student use and development of the elements of these PEs under Criterion I.B.
MS-ESS2-1. *Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.* This is the focus of Lesson 1.
MS-ESS3-2. *Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.* This is the focus of Lessons 2 and 3.

Suggestions for Improvement
Consider ensuring that students consistently see the linkages between each activity.

I.E. MULTIPLE SCIENCE DOMAINS

When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.

ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that links are made across the science domains when appropriate. The study of volcanoes in this unit can be fully addressed by the Earth and space science domain, although some appropriate linkages are made to physical sciences. However, CCCs are not used to explicitly connect across domains for sense-making or problem solving.

Both Earth sciences and physical sciences are referenced in the module. For example, in Lesson 1, Session 3, one of the readings describes chemical reactions and rearrangement of atoms in a mineral (Weathering and Erosion Article handout), and students use this information as they make sense of the phenomena. However, the element from the physical sciences is only partially used as it is not a focus of the unit.

Suggestions for Improvement

Consider supporting students to see how CCCs can connect across scientific domains, including to domains used in prior instruction.

I.F. MATH AND ELA

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

Rating for Criterion I.F. Math and ELA	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics and English language arts (ELA). CCSS standards are stated explicitly in each lesson, and students have many opportunities to use CCSS-ELA standards. However, students are not regularly supported to see how their use of ELA and literacy helps their science sense-making.

The eight Standards for Mathematical Practice are listed on the Standards page of the unit, and the Teacher Edition indicates in which lesson six of those standards are used. Several CCSS-ELA standards are listed on the same page, including:

- **RST.6-8.1.** *Cite specific textual evidence to support analysis of science and technical texts*.
- **RST.6-8.7.** *Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).*
- **WHST.6-8.1.** *Write arguments focused on discipline-specific content*.

Several ELA/Literacy standards are also claimed in each lesson along with Standards for Mathematical Practices, although they are not always used in the lessons, and students are rarely supported to see how their mathematics or ELA activities support their science learning. For example:

- Lesson 1, Session 3: In the online standards tab, there is one CCSS-M standard claimed (**MP8**: *Look for and express regularity in repeated reasoning*) and 10 CCSS-ELA/Literacy standards claimed, including **WHST.6-8.10**: *Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences*. The session asks students to read and process three articles about erosion processes. However, nothing in the sequence of actions accomplished by students would obviously require or evoke **MP8** or **WHST.6-8.10**.
- Lesson 3, Session 3: The following mathematics standard is claimed in the standards tab: "**MP3**: *Construct viable arguments and critique the reasoning of others*." Students make several graphs that reflect volcano monitoring data. In the teacher tab, instructions to the teacher say, "Share Findings. Have students share their graphs with their teammates. Note: Students with datasets closer to the eruption should notice more overlapping peaks than students with datasets far from the eruption. Analyze and Interpret Data. Ask teams to assign the correct period to each of the Historic Dataset handout pages (ten days before, two months before, six months before, or

several years before). Have them arrange their pages in order and record this on page 105 in their Twig Journals. Reveal the correct order of the pages. Have students rearrange their pages if necessary. Ask teams to discuss what types of readings demonstrate increasing volcanic activity and write their answers on page 105 in their Twig Journals." These instructions have the potential of giving students the opportunity to exhibit competence on the claimed mathematics standard.

- Students are not explicitly prompted to connect mathematics to their science learning, and only have implicit support for similar connections to ELA, such as in Lesson 2, Session 4: "Have partners take turns reading the paragraphs in the article aloud. While each partner reads, allow time for them to consult the word wall. Have them retell what they have read to confirm understanding. Listen to individual students read, and work with ELs to improve pacing and fluency. Then, have pairs complete the graphic organizer in their Twig Journals." In this example, students may begin to see how their close reading supports their scientific understanding.

Students engage in group discussions throughout the module (see examples under Criterion II.B) and are asked to write many times during the module. Blog posts and informational texts are used as reading texts for students, but other reading formats (e.g., scientific articles adapted for classroom use) are not included in the module.

Suggestions for Improvement

Consider providing support to help students see the connection between the ELA/literacy activity and their science learning. This could include facilitator prompts to point out the connections.

OVERALL CATEGORY I SCORE: 2 (0, 1, 2, 3)	
Unit Scoring Guide – Category I	
Criteria A-F	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

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

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authenticity	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world. There are several opportunities for students to experience nature directly and most of the activities are likely to be engaging and fun for students. Teachers are also sometimes prompted to connect volcano-related information to students' own experiences.

Students observe the phenomena as directly as possible. For example:

- Lesson 1, Session 1: Students observe images of four different mountains. A teacher note says, "If some students are less familiar with volcanoes, consider providing the whole class with a short, unnarrated video or image of a volcano or volcanic eruption. Invite students to share descriptions of an imagined volcano or the provided volcano example with a partner" (online only). Students also physically handle rock samples. "Distribute a set of rock samples and a hand lens to each team. Explain that the numbered bags contain rock samples similar to rocks found in the four locations shown in their Twig Journals."
- Where direct observations are not possible, students are supported to observe models of real-world phenomena and to discuss the differences between the models and the real world. For example:
  - Lesson 1, Session 4: Students engage in a hands-on investigation with crayons. The aim of this direct experience is to mimic changes in types of rocks (sedimentary, igneous, and metamorphic).
  - Lesson 2, Session 2: Students model lava viscosity by determining how fast various household liquids flow down a slope, with and without impediments. This is a direct interaction with a phenomenon, but not, of course, directly with lava.
  - Lesson 2, Session 3: Students blow bubbles into the same set of four household liquids as in Session 2 above. The goal is for students to begin forming ideas about the cause of explosive volcanoes. However, there is a missed opportunity for students to observe (via

video or classroom demonstration) how liquids rise in narrow tubes due to heating. Varying tube diameter and amount of heating could simulate different volcano parameters in a more engaging way than doing a computer simulation.
- Students engage in several simulations throughout the unit.

Students are supported to understand that the phenomena are important to people in the real world. For example:

- The focus of Lesson 2 is determining the relative danger of volcanoes, and the focus of Lesson 3 is determining how to help communities avoid harm from volcanoes.
- Lesson 2, Session 1: The lesson begins by showing the effects of a volcano on peoples' homes. Students are asked, "What effects do you think the eruption had on people living nearby?" An example student response says, "I think people died because of the eruption." The teacher is told to "Let students know that 353 people died and over 350,000 people were evacuated from the area." Students are therefore supported to understand that the phenomenon is important to people.
- Lesson 2, Session 4: Students are supported to realize the importance of their work in class. They are asked to "Analyze and interpret the patterns in the data and determine which of these volcanoes is likely to be more dangerous, and why." Example student answers include "These can harm people, their property, and the environment."

Connections are made throughout the module to students' lives. Some support is also provided for teachers when anticipating issues that may arise related to student engagement with sensitive content. For example:

- A family letter is provided such that students could give it to their family members. The letter includes a section called "Engaging in Conversation with Students." The section states, "To help drive a conversation about what happened in science class today, you could ask: What phenomena were you investigating? What new questions were you trying to answer? What new questions did you generate?" (page 4). With this kind of guidance some family members might engage students in conversations about their science learning. The family member is also told, "You can also enhance your student's learning by connecting the science they are exploring in class to their experiences at home and in the world" (page 5), but examples or specific guidance are not provided (page 5).
- Lesson 1, Session 1: Students are asked to "Think about a volcano you have seen or learned about in the media. Describe your volcano to a partner. Tell them about the landscape, rocks, lava, and any sounds it made" (slide 5). The teacher directions say, "Arrange students into teams of four. Invite students to observe the images, statements, and map on pages 8–11 in their Twig Journals. Encourage students to consider how these pieces of evidence may connect with their own lives, places, and experiences. Prompt students to make a note of any observations on page 11."
- Lesson 1, Session 3: "This session uses the phenomenon of a shield volcano in Hawaii to drive student sense-making of the processes that cause a volcanic landscape to change over time. You

may choose to introduce an additional local phenomenon in this session to support students' sensemaking of weathering, erosion, or deposition."

- Lesson 1, Session 4: The teacher is prompted to say, "What do you observe about these rocks? How are they similar to or different from rocks you have observed in places you have lived or visited?"
- Lesson 1, Session 4: "Students could use samples of igneous, metamorphic, and sedimentary rock from their own area as an additional investigative phenomenon for this session. If students make observations of rocks from their own area, ensure that they relate their understanding both to their own rock samples and the rocks that exist near the locations described in the Anchor Phenomenon."
- Lesson 1, Session 8: "Honors and Advanced Extension: Are There Any Volcanoes Near Me? Students complete a research project about their local area, predicting whether there are any volcanoes in their region and justifying their predictions with geologic evidence." However, this activity is not intended for all students, so it is unlikely that many students will use it to connect to their local areas.
- Lesson 2, Session 4: "You may choose to introduce an additional phenomenon in this session based on natural events in your region, such as hurricanes, earthquakes, or tornadoes, to support students' understanding of the relationship between past and potential future events. Note that extreme care should be taken in selecting and discussing recent local natural hazards, and topics that students might find disturbing or upsetting should be avoided."
- Lesson 2, Session 5: "Be aware that the article includes details of some of the fatalities that occurred as a result of the eruption, which some students may find upsetting."
- Lesson 2, Session 5: "Students may have anecdotes or prior knowledge they have gathered from any family members who lived in the Pacific Northwest in 1980 and experienced effects from the eruption of Mount St. Helens. In addition, some students may have visited Mount St. Helens National Volcanic Monument and have observations of the volcano in its current state. If they have any of these experiences, invite them to share them with the class."
- Lesson 3, Session 4: "Students may have used weather apps displaying severe weather warnings, noticed a fire danger scale posted in an area prone to wildfire, or heard a high surf advisory on the radio in a coastal area. Ask students to share any warning systems for potential hazards that they are familiar with."

Students are somewhat supported to connect their questions to their experiences. The Module Wonder Questions handout says, "If students are having difficulty generating questions about monitoring volcanoes or protecting residents from volcanic activity, consider prompting them to think about another natural disaster they may be more familiar with. Care should be taken in this discussion as students, their families, or their communities may have personal experience with natural disasters that make some aspects of the discussion distressing" (page 4).

Suggestions for Improvement

Consider connecting the anchoring phenomenon idea of volcanoes "affecting local residents" more concretely earlier in the unit. For example, the focus of the anchor phenomenon throughout the unit could be on the effects of a volcano on a family, prompted by a video interview with a family in the beginning of Lesson 1.

II.B. STUDENT IDEAS

Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

Rating for Criterion II.B. Student Ideas	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas. The materials provide many opportunities for students to share their ideas with peers and respond to feedback. However, teacher supports for eliciting student ideas are often generic (not customized to specific activities) and therefore might not be implemented similarly in all classrooms.

Opportunities are provided throughout the materials to elicit student thinking and to prompt students to justify and clarify their ideas. Related evidence includes:

- Throughout the module, students use a Phenomena Tracker Routine to reflect on and record their evolving sense-making, creating artifacts of their changing reasoning over time.
- Lesson 1, Session 1: There is a teacher note about encouraging students to investigate their thought processes if they think they are "not good at science and technology," but the guidance is not connected in any way to the lesson activities or content.
- Lesson 1, Session 1: The teacher is told to "Ensure that all students feel supported in answering these questions by increasing wait time, pairing or grouping students to discuss and develop responses, and allowing students to respond in different modalities."
- Lesson 1, Session 2: "Prompt students to explain why the evidence they have cited in their responses helps them understand where volcanoes may be found."
- Lesson 1, Session 6: "Use the Productive Discussion language routine with pairs or small groups of students. Prompt students to support their answers with evidence from their models, and provide feedback to help students understand and articulate connections between rock types and the crosscutting concepts of Energy and Matter and Stability and Change. In feedback to students, emphasize conceptual understanding rather than use of new vocabulary."
- Lesson 1, Session 7: "Ask students to pair up to verbally share their thinking. As Student 1 shares, Student 2 should listen carefully and ask for clarity, reasoning, details, and examples that

support Student 1's thinking. Students then switch roles." The revision process provides students the opportunity to cite relevant evidence, pose questions, and elicit elaborations.
- Lesson 2, Session 3: "What is the relationship between viscosity, gas content, and explosivity? Use evidence to justify your answer."
- Lesson, Session 3: Students are asked to "Think about how your understanding about the discussion prompt has changed" (slide 43).
- Lesson 2, Session 6: "Use talk moves to prompt students to add detail to their own and one another's observations."
- Lesson 2, Session 6: The teacher is asked to "Use the Meta-Think Aloud language routine to encourage students to engage in metacognition and to use this as a strategy when they engage in complex tasks. Clearly model your thinking around evidence and reasoning relating to the danger posed by different types of volcanoes so that students can follow your thought process."
- Lesson 3, Session 3: "Ensure that all students feel supported in answering these questions by increasing wait time, pairing or grouping students to discuss and develop responses, and allowing students to respond in different modalities. Consider using talk moves included in the Think Talk—Productive Discussion language routine described in the Vocabulary and Language Guide to support all students in sharing their ideas and responding to their peers."

Teacher and peer feedback opportunities are explicitly elicited throughout the module, although examples of what feedback could look like are not provided. Related evidence includes:
- Lesson 1, Session 2: "Offer feedback to students on their use of evidence from the Volcano Explorer digital interactive and 'At the Plate Boundaries' article, but avoid heavily relying on vocabulary from the article that may be new to students." Explicit guidance on the feedback teachers could provide or examples of what feedback could look like are not provided.
- Lesson 1, Session 4: "Circulate as students generate ideas of methods they might use to model different processes. If needed, remind students that they explored some of these processes in Session 3. Prompt students to explain, in their own words, how a process in their model might change the crayons, and how this process relates to a real-world process that changes rocks. Offer feedback to students on their explanation of how their chosen processes model the geological processes they learned about in Session 3, and on students' identification of forces and energy transfers as part of those processes." Explicit guidance on the feedback teachers could provide or examples of what feedback could look like are not provided.
- Lesson 1, Session 7: The teacher is told to "Have students exchange Twig Journals with a partner and provide feedback on the graphic organizer." Students are told, "After working with your partners, revise your response so it is stronger and clearer." Explicit guidance on the feedback students could provide is not provided.
- Lesson 2, Session 5: "Have students exchange Twig Journals with a partner and provide feedback on the graphic organizer. They should look for: Completed graphic organizers, Detailed answers, Clearly communicated ideas." However, student feedback is not focused on the content of their peers' ideas, but rather the level of detail and clarity.
- Lesson 3, Session 1: Teachers are told, "When providing feedback, look and listen for student language that demonstrates conceptual understanding of these tools and data types rather than

correct use of the names of the tools… Circulate as students pair-share to discuss their responses. Remind students, as needed, that their goal is to analyze their graphs to identify patterns between values in the data and the timing of eruptions. Provide feedback to students on their analysis of both their tables and graphs, and their identification of similarities and differences between data from different sources."

- Lesson 3, Session 3: "Circulate to support scientific discussion, using talk moves to elicit evidence and help expand and clarify student thinking. Provide feedback on the students' analysis and interpretation of the data (including their identification of similarities and differences between data from different sources), and their use of their graphs as evidence to support their answers."
- Lesson 3, Session 6: Student teams are told, "Share your feedback with the other team. Listen to the other team's feedback on your plan. How might you revise your plan to make it better? Update your monitoring plan" (slide 91). Students are given the student rubric and the teacher is told to "explain that students will use this to peer assess the presenting team's plan today."

Suggestions for Improvement

Consider providing more context-specific teacher supports for eliciting student thinking.

II.C. BUILDING PROGRESSIONS

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions
ii. Clearly explaining how the prior learning will be built upon.

Rating for Criterion II.C. Building Progressions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions. Element level prior learning and learning waypoints are clearly provided for teachers, although specific descriptions of how learning progresses (such as through which activities) are not provided, and one section of one learning progression in the module is somewhat incoherent.

A Performance Expectation Progressions document is provided that includes guidance about learning progressions. Related evidence includes:

- "To meet the module Performance Expectations, students build on knowledge, skills, and practices developed in elementary school and lay the foundations for those to come in high school" (page 1).

- Tables are included for each lesson that list "Prior Knowledge" from Grades 3–5, "Working Toward in Middle School," and "Future Knowledge" in high school. One example relates to the CCC of **Stability and Change**:
    - Prior Knowledge: "E1: Change is measured in terms of differences over time and may occur at different rates. E2: Some systems appear stable, but over long periods of time will eventually change." However, this is a grade 7 unit, and prior learning from grade 6 is not mentioned.
    - Working Toward in Middle School: "M1: Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale."
    - Future Knowledge: "H1: Much of science deals with constructing explanations of how things change and how they remain stable."
- Tables are included that highlight which parts of current learning goals for all three dimensions that "students are working with" in each lesson and session. For example, the following two targets are described in the "Working Toward Mastery" column:
    - "Lesson 2 Session 3: Analyze and interpret data to determine similarities and differences in findings.
    - Lesson 2 Session 4: Analyze and interpret data to determine similarities and differences in findings" (page 9).

A Prior Knowledge document is provided for teachers. It lists:

- Disciplinary concepts students are expected to know "prior to undertaking this module" from both elementary and middle school (page 1);
- Vocabulary students are expected to know "prior to starting this module" (page 1);
- An explanation of two context videos. "These videos are available to help students recap the key terms and concepts they need to know prior to starting this module. Some of the videos are aimed at audiences younger than your students, but they include important knowledge-building content. To support your students' understanding of this content, invite them to review the videos and list any key learning that a younger audience would take away after viewing" (page 2).

Most of the learning in the module progresses logically, with one exception. In Lesson 2, Session 6, students are expected to demonstrate mastery in a full SEP element (*Analyze and interpret data to determine similarities and differences in findings*) in an interim assessment. Then in both Lesson 3, Sessions 1 and 3, the same element is claimed as an opportunity for students to work toward mastery. This learning progression is therefore somewhat incoherent.

Suggestions for Improvement

- Consider ensuring that a possible learning path from prior learning through targeted learning (including waypoints connected to specific activities) for all learning goals is clear to teachers.
- Consider clarifying for teachers potential alternate conceptions that students might have in relation to each of the learning targets.

- Consider clarifying for teachers whether the Lesson 2, Session 6 assessment is to be used as a check on student progress rather than an expectation that all students are already demonstrating full mastery of the SEP element.

II.D. SCIENTIFIC ACCURACY

Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

Rating for Criterion II.D. Scientific Accuracy	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials use scientifically accurate and grade-appropriate scientific information because all scientific information in the module is accurate.

Teacher Background information is provided throughout the unit in the online interactive Teacher Guide. This allows teachers to feel comfortable with the disciplinary content knowledge used in the module.

There are a few small examples of potentially incomplete information in the module that might lead to misconceptions. For example:

- The materials do not discuss any hierarchical difference between mountains and volcanoes. There is a categorical difference that is not discussed in the materials; a volcano can be a mountain, but not all mountains are volcanoes.
- Lesson 2, Sessions 2–3: Students investigate volcano explosiveness, primarily by learning about viscosity. At the end of this learning sequence, the teacher materials have a section headed, "Explaining Explosivity." The explanation does not include the role of energy, which is a primary consideration in eruptions. There is a supplemental lesson about energy at the end of Session 2, but it is optional.
- Lesson 3: The driving question for the lesson is "How can we protect communities at risk from volcanoes?" Students eventually generate a proposal that is supposed to help address this question. They develop a monitoring plan that uses a danger rating and subsequent warning protocol. However, the materials do not provide data on the effectiveness of monitoring systems or warning protocols, and there is only one mention of monitoring systems being incomplete. This focus on only the monitoring plan might lead to the misconception that monitoring and warning is equivalent to protecting.
- Lesson 3, Session 3: In the Twig Journal, the heading for one of the tables might be slightly misleading. Students are asked to "Obtain Information" on one chart and then to "Evaluate Information" on the chart on the next page. It is therefore likely that users will associate these

terms with the SEP **Obtaining, Evaluating, and Communicating Information**. However, the "Evaluate Information" table only asks students to categorize information presented in the blog posts — not to evaluate the blog posts themselves as sources of information or to evaluate the blog posts' claims on their validity (as "evaluating" is used in the SEP).

Suggestions for Improvement

Consider clarifying the examples mentioned in the evidence section above to ensure that students have grade-appropriate understanding of the related ideas.

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities that are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction. Extensive supports are provided for struggling students related to the module learning goals in all three dimensions. All students, including multilingual learners, are well-supported to access the learning and to communicate their ideas, and some opportunities for extending learning are provided. However, many of the supports for differentiated learning are not tailored to specific learning goals, and conflicting messages are given in relation to supporting students' acquisition of vocabulary.

Extensive supports are provided for students struggling in relation to specific learning goals, although the teacher is not often supported to identify struggling students. Related evidence includes:

- Lesson 1, Session 1: In a sidebar section labeled "Below-Level Learners," the teacher is told to "Support students in asking questions using the Asking Questions and Defining Problems handout."
- Lesson 1, Session 2: "Students may not have developed the skills to carry out an investigation to identify patterns. Support these students with the Planning and Carrying Out Investigations

handout. For students who struggle to identify patterns, use the Patterns handout to help them draw conclusions from their observations of the Volcano Explorer digital interactive."

- Lesson 1, Session 3: "Scaffold Stations 5 and 6 for students by playing the Erosion and Weathering Video."
- Lesson 1, Session 3: "Below-Level Learners. For students who struggle with the concept of slow or fast changes over different timescales, use the Stability and Change handout to scaffold the activity."
- Lesson 1, Session 3: At the end of the session there is an optional activity. "This 5-minute activity is designed as an extra resource to support students who could benefit from reviewing the cycle of energy and matter within other Earth's systems, and those students who have not yet been introduced to the water cycle. You may wish to use this activity if students have not yet completed the Great Air Race module."
- Lesson 1, Session 4: "Students do not need to have accurate predictions at this point. If students are struggling to generate ideas about how the rocks formed, prompt them to consider the processes, forces, and sources of energy they discussed in the previous session and how these might affect the appearance of rocks."
- Lesson 1, Session 8: "If students are struggling to identify evidence to support their claim, prompt them to review their Phenomena Trackers and landscape models and consider the investigations that provided the evidence they used to develop their models."
- Lesson 3, Session 3: "For students who struggle to interpret the historic dataset, use a brief think-aloud to model how to analyze and draw conclusions from data. Additional supports, including Sentence Frames, are available in the Analyzing and Interpreting Data handout."

Supports are provided for multilingual learners and for all students to develop scientific language. However, these supports provide conflicting advice about vocabulary acquisition. Related evidence includes:

- A Vocabulary and Language Guide is provided that describes the module's philosophy on building students' vocabulary, and provides several supports for building vocabulary. However, the guide describes a vocabulary-first view of the relationship between language and science, rather than the science meaning-first view supported by research. For example, the stages are described as: 1) Reception. Students are introduced to new words within a specific context and reminded of the word as it is iterated in its multiple forms. Students will see the word written, hear it spoken, and have their understanding supported through associated imagery; 2) Practice. Students are provided with definitions in student-friendly language and are encouraged to linger on these definitions through suggested activities and discussion prompts; 3) Production. Through language routines, students are asked to define the key terms using their own language; and 4) Self-Assessment and Reflection. Students are encouraged to "return to new vocabulary frequently…." "Sometimes you may want students to engage with the key terms on the lesson vocabulary list prior to starting the sessions" (Vocabulary and Language Guide, page 22). Note that other parts of the module emphasize that the teacher should focus on students' descriptions of ideas rather than correct scientific terminology (e.g., Lesson 1, Session 6, slide 86 facilitation notes: "In feedback to students, emphasize conceptual understanding rather than use of new vocabulary.")

- Both the student materials and their answer key are available in Spanish. Therefore, the student-facing texts to read are available in Spanish. However, they are not available in other languages, and guidance is not provided about how to help students find the articles to read in their home languages other than Spanish.
- Lesson 1, Session 3: "Display English language closed captioning while the Birth of a Volcano video plays. Make printed copies of the video transcript available for students and/or allow students to access the video and transcript in their Twig Science accounts. Allow time for students to rewatch the video (including rewatching the video in Spanish, if helpful) prior to answering questions or making observations."
- Lesson 1, Session 3: A sidebar titled "English Learners" provides varying levels of possible supports to provide. "Emerging Proficiency. Allow ELs to read their notes directly from their Twig Journals. Expanding Proficiency. Allow ELs to read their notes directly from their Twig Journals, but encourage them to answer in their own words. Have their teams support them with essential vocabulary and pronunciation."
- Lesson 1, Session 6: "Gather ELs in a small group to read, highlight, annotate, and take notes from the article. Emphasize how to highlight unfamiliar terms and scientific vocabulary. Model the use of context clues to help students figure out the meaning of unfamiliar terms. Invite students to engage in a clue hunt to identify as many clues as they can in the text surrounding the term to determine its meaning. Model a reading of the first paragraph or two and then ask the group to take turns reading the article aloud. Have group members work together to complete the graphic organizer in their Twig Journals."
- Lesson 2, Session 1: "Pair ELs with a partner who has a higher level of English proficiency to help them share their observations before the discussion. Write volcano and eruption on the board, say each word, and have students repeat it. Show the visual and point to the damage the eruption caused. Model how to describe what's happening to support students' ability to describe what they're seeing before and after the volcanic eruption. Invite students to repeat, modify, or add to your descriptions with words or gestures." Note that this support comes almost halfway through the module about volcanoes, so is likely to be redundant at this point.
- Lesson 2, Session 4: "Have partners take turns reading the paragraphs in the article aloud. While each partner reads, allow time for them to consult the word wall. Have them retell what they have read to confirm understanding. Listen to individual students read, and work with ELs to improve pacing and fluency. Then, have pairs complete the graphic organizer in their Twig Journals."
- Lesson 2, Session 5: "Display English language closed captioning while the video plays. Make printed copies of the video transcript available for students and/or allow students to access the video and transcript in their Twig Science accounts. Allow time for students to rewatch the video (including rewatching the video in Spanish, if helpful) prior to answering questions or making observations. Support students' use of the Video Viewing Guide in the Teaching and Research Aids to help students comprehend the phenomenon."

- Lesson 3, Session 1: "Use gestures while explaining keywords in the data collection table and connect these terms to events in the video. Encourage ELs to use extra paper to annotate the sheets in their home languages."
- Lesson 3, Session 5: "Before ELs join their teams, use gestures and labeled visuals to explain the Undermonitored Volcanoes handout and the information their team will consider. Pair ELs with a student of higher English proficiency to read and annotate the eruptive histories."

Supports are provided for students with physical challenges. For example:

- Lesson 1, Session 3: A teacher sidebar note says, "Provide support for students with physical limitations. Give assistance as students move to their station and while they complete the activity."
- Lesson 1, Session 4: A teacher sidebar note says, "Fine Motor Skills. Encourage students who struggle with fine motor skills to take on an instructional role while those tools are being used. Ensure students are engaged in modeling geologic processes."
- Lesson 2, Session 1: "With student permission, provide assistance to those with limited mobility as you move outside."

Additional supports are provided for the needs of individual students. For example:

- Lesson 2, Session 1: Students can complete the Phenomena Tracker as a paired or individual written task rather than as a discussion, or as a class discussion rather than peer discussion, depending on student needs and preferences. Allow students to use both text and drawings if completing it as a written task.
- Lesson 2, Session 3: "Provide Multiple Means of Representation. Create a table with the column headers 'low viscosity' and 'high viscosity,' and the row headers 'low gas content' and 'high gas content.' As students share, record their ideas in the table about which combinations of characteristics will result in more or less explosive eruptions."
- Lesson 2, Session 5: "If students are struggling with comprehension of geographical locations, provide them with a map of Washington and locate the following places on the map: Mount St. Helens, Mount Adams, Yakima…"
- Lesson 3, Session 1: "Some students may need support remaining focused on the data collection task at stations with large groups of students from other teams. Provide visual and/or auditory cues to help students manage their time and improve focus."
- Lesson 3, Session 3: "Visual–Spatial Processing. Use a blank sheet of paper to model how to focus on one dataset at a time. Cover other datasets with the paper while graphing one dataset. Have students use a different color for each data type on the graph (e.g., temperature in yellow, seismic in blue)."

Several extensions are provided throughout the unit, but the learning target(s) they are meant to extend are not made clear. Examples include:

- At the end of Lesson 1, Session 2, there is a "Suggested Integrated 3-D Challenge Connection" related to Yellowstone National Park. It is unclear whether this challenge is for all students.

- Lesson 1, Session 6: “For students who could benefit from a challenge, have them use their landscape models to debate the question: Is it possible for a rock to be two or three types at the same time?”
- Lesson 1, Session 6: “Honors and Advanced Extension: Applying Rock Cycle Knowledge. Students compare their landscape models to a classic rock cycle diagram before using their rock cycle understanding to determine if different rocks are volcanic or not.”
- Lesson 1, Session 8: “Honors and Advanced Extension: Are There Any Volcanoes Near Me? Students complete a research project about their local area, predicting whether there are any volcanoes in their region and justifying their predictions with geologic evidence.”
- At the end of Lesson 2, Session 1, there is a “Suggested Integrated 3-D Challenge Connection” “What is a Supereruption?” It is unclear whether this challenge is for all students.
- Lesson 2, Session 5: “Honors and Advanced Extension: Topographic Effects of Volcanic Eruptions.”
- At the end of Lesson 3, Session 6, there is a “Suggested Integrated 3-D Challenge Connection” related to Energy Transfers. It is unclear whether this challenge is for all students.

Suggestions for Improvement

- Consider revising the vocabulary approach described in the Vocabulary and Language Guide to begin with students describing ideas in their own language, which allows them to realize the need for the specific vocabulary word.
- Consider tailoring differentiated instructional supports to the context of specific activities and learning goals. This could include providing specific examples of how the generic guidance (like “talk moves”) could be applied in specific situations.
- Consider providing strategies to support students who begin the unit with a significantly higher or lower proficiency level than expected.

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time because explicit instructions are given to both teachers and students to connect sense-making to learning in the focal elements of all three dimensions.

Frequent guidance is given to teachers to help understand the full module storyline and to help link student engagement between sessions. Related evidence includes:

- Teachers are given a Phenomena Tracker to show the full storyline of sense-making throughout the unit. This table includes color coding of the "Outcomes of Sense Making [sic]." For example, an outcome of Lesson 2, Session 2 is listed as "The properties of lava and how it behaves can be changed and compared; viscosity, slope, and debris affect how slowly or quickly lava flows."
- At the beginning of each lesson, the teacher is given a lesson outline in 5E Instructional Flow form, showing which sessions are a part of which of the 5Es. For example, Lesson 1, Session 1 falls under Engage, and Sessions 2–6 fall under Explore/Explain.
- Slides are provided as instructional aides, and the presenter notes for each slide include a hyperlink to a specific section of the teacher instructions online. However, references are not made in the other direction, so teachers might need to make their own notes about when to use the slides in order for the student presentation to be coherent. In addition, some of the slides seem out of place, such as the slide at the end of the second to last session in the module asking students "Which question should we try to answer next?" After students have already been told "You will have the opportunity to review and update your [volcano monitoring] plans at the beginning of the next session" (Lesson 3, slide 82). If a teacher uses this slide in this location in the module, it might be confusing and seem incoherent for students.
- At the end of most sessions in the online version of the teacher guide, within the Exit Ticket section there is this comment about future lessons: "Refer to the Assessment Overview and/or Classroom Slides online for more details on student use of the three dimensions, recommendations on interpreting student answers, and guidelines for adapting instruction and

using student ideas in later instruction." However, the possible connections between the current session and future sessions are not explicit or session specific.

- Navigation prompts are provided in many sessions to help students make connections to prior activities. For example:
  - Lesson 1, Session 7: Early in the session teachers are told, "Students review their learning about the life cycle of a volcano by reassembling the story about Hawaii's volcanoes." This activity is concrete guidance at the beginning of the session designed to have students remember and then use knowledge from Session 6 in preparation for new knowledge in Session 7.
  - Lesson 2, Session 1: The session begins with this statement, "Ask students to recall the four locations they were investigating in Lesson 1. Optional: Prompt them to look at the images on pages 8–10 in their Twig Journals." Students look at before and after photographs of the region around Yogyakarta, one of the original four locations at the beginning of the unit.

Supports are provided for helping students see how their learning in each of the three dimensions supports their sense-making. However, these supports often focus on the category level rather than on individual elements of the three dimensions. Related evidence includes:

- The Module Wonder Questions Handout provides guidance that would help the teacher facilitate a coherent learning experience for students as well as help them understand connections between their sense-making and their learning in the three dimensions. For example, "Guide students to identify that there may be evidence of both changing and stable landscapes that is difficult to observe. This is important for helping students understand why modeling is an important tool for understanding changes in the landscape" (page 3). "As students progress through Lesson 2, support them in determining how they might be able to measure the threat posed by different hazards associated with volcanoes. This will be especially helpful for guiding students to understand how the Science and Engineering Practice of Analyzing and Interpreting Data and the Crosscutting Concept of Patterns are important for evaluating the risk of natural hazards" (page 4).
- The Phenomena Tracker Routine visual is used periodically during the module to support students in connecting their learning to their sense-making. For example:
  - Lesson 1: "Record how you have used the scientific practice of developing and using models and considered the crosscutting concept of stability and change to figure this out. How have models helped you answer the Wonder Questions and explain the Investigative Phenomena? How has thinking about stability and change helped you answer the Wonder Questions and understand the Investigative Phenomena?"
  - Lesson 2: "Record how you have used the scientific practice of analyzing and interpreting data, and considered the crosscutting concept of patterns to figure this out. How has analyzing and interpreting data helped you answer the Wonder Questions and explain the Investigative Phenomena?"
- Lesson 1, Session 8: After students return to the anchor phenomenon to see how much they can explain, the teacher is told to "Remind them to include information about how they used the

scientific practice of developing and using models, and thought about the phenomena through the lens of stability and change."

- Lesson 2, Session 1: "Help students connect to ideas from Lesson 1 regarding why models are useful for understanding some phenomena."
- Lesson 2, Session 6: After students return to the anchor phenomenon to see how much they can explain, the teacher is told to "Remind them to include information about how they used the scientific practice of analyzing and interpreting data, and thought about the phenomena through the lens of patterns."
- Lesson 3, Session 6: After students return to the anchor phenomenon to see how much they can explain, they are asked to "Remember to include information about how you analyzed and interpreted data, and thought about patterns to make sense of phenomena" (slide 94).

Suggestions for Improvement

Consider adding slide numbers to the teacher instructions such that teachers would know when to use each slide. This would avoid confusion or extra work for the teacher.

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

Rating for Criterion II.G. Scaffolded Differentiation Over Time	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time. Two focal SEP elements are claimed in the module, along with several other non-focal elements. Detailed handouts are provided for helping all students build proficiency in targeted SEPs. For the focal elements, some prompts are provided for helping teachers add or remove scaffolding as appropriate for student needs.

Students are expected to progressively develop mastery in the focal SEP elements during the module. Optional supports (handouts with exercises) are provided for each SEP category and teachers are prompted from time to time during the module about when use of these supports might be helpful for students who are struggling. Related evidence includes:

- Focal Element: *Develop and/or use a model to predict and/or describe phenomena.*
    - Lesson 1, Session 1: An Optional "Developing and Using Models Handout" is linked. In the pre-assessment, students are asked to use a model to make a prediction.

  - Lesson 1, Session 4: This element is partially claimed (not the "predict" part) as an opportunity for students to work toward mastery. Students use crayons to develop models of different kinds of rock formations and discuss how their models do and do not represent real rocks. A student response says, "The models show the types of energy flows and processes that might form real rocks, like how pressure or energy from the inside of the Earth could cause a rock to melt or look squished together." Students also update model drawings in their Twig Journals, and the teacher is directed to "Prompt them to add arrows to show the flow of energy," therefore providing some scaffolding.
  - Lesson 1, Session 5: This element is partially claimed (not the "predict" part) as an opportunity for students to work toward mastery. At the end of the session students are asked to "Revisit the landscape model. Update and use your model to describe the processes that caused the observable changes in the landscape. Be sure to include the source(s) and flow of energy and the movement of matter." The teacher is told, "After this session, students should be demonstrating mastery of the Developing and Using Models science and engineering practice. Monitor individual student progress in this practice and consider removing scaffolds when students are able to demonstrate mastery in this practice independently."
  - Lesson 1, Session 7: This element is partially claimed (not the "predict" part) as an opportunity for students to demonstrate mastery. "Ask students to turn to page 53 in their Twig Journals to draw a diagram that illustrates the steps that occurred at the plate boundary during Phase 1 of Mount Mazama's creation. Encourage students to add labels and use arrows to demonstrate how the materials cycle through the landscape." As students draw their own model, they are progressing in their use of the element.
  - Lesson 1, Session 8: This element is partially claimed (not the "predict" part) as an opportunity for students to demonstrate mastery. In the summative assessment, the "proficient" level of student performance in the rubric says, "Student constructs explanations of stability and change in a landscape by using the model to describe the changes to rocks over time and the processes that result in these changes at different scales, including the atomic scale" (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5). No specific teacher scaffolding is provided.
- Focal Element: *Analyze and interpret data to determine similarities and differences in findings*.
  - Lesson 2, Session 3: This element is partially claimed (not the "similarities" part) as an opportunity for students to work toward mastery. Students use a digital interactive activity and record their observations using differing conditions for the simulation. They are prompted to answer the question "What is the relationship between viscosity, gas content, and explosivity? Use evidence to justify your answer."
  - Lesson 2, Session 4: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked to read a text that includes data tables, and to "record similarities or differences in height, VEI, eruption or volcano types, and population size." Students continue to practice using this element.

- Lesson 2, Session 6: This element is fully claimed as an opportunity for students to demonstrate mastery on an interim assessment. Students are asked to "Analyze and interpret the data in the Dangers of Volcanoes handout and on pages 65-66, 67, and 75. Use the patterns that you notice as evidence to support an argument that some volcanoes present a greater hazard than others."
- Lesson 3, Session 1: This element is partially claimed (not the "similarities" part) as an opportunity for students to work toward mastery. Note that less mastery is expected here than in Lesson 2, Session 6. The teacher is told to "Challenge students to identify which techniques they are going to use to analyze the data, and why. Provide blank chart paper and encourage them to create graphs." "Have teams analyze the similarities and differences in their data, looking for patterns and considering what different monitors showed when the volcano was erupting."
- Lesson 3, Session 3: This element is fully claimed as an opportunity for students to work toward mastery. Note that less mastery is expected here than in Lesson 2, Session 6. Students graph and then analyze data and are asked, "Are there two or more data types that follow the same trend or pattern? What could this mean?" The sample student response says, "It could mean that both data types are connected to each other. If one reading increases, it affects another in the same way." Teachers are told to "provide feedback on the students' analysis and interpretation of the data (including their identification of similarities and differences between data from different sources), and their use of their graphs as evidence to support their answers."
- Lesson 3, Session 3: "Monitor individual student progress in the Analyzing and Interpreting Data science and engineering practice. For students who struggle to interpret the historic dataset, use a brief think-aloud to model how to analyze and draw conclusions from data. Additional supports, including Sentence Frames, are available in the Analyzing and Interpreting Data handout. For students who are demonstrating mastery of this practice (or approaching this point), consider removing scaffolds to enable the student to demonstrate mastery in this practice independently." However, it is not clear what scaffolds should be removed for students who are demonstrating mastery other than those introduced for students who struggle.
- Lesson 3, Session 4: This element is fully claimed as an opportunity for students to demonstrate mastery. Students are asked, "What evidence in the [two months before] dataset tells you this volcano requires a [Watch] warning?" The sample student answer says, "The data has high values, and there are some overlapping peaks between data types. But the values aren't as high as they are in the [ten days before] dataset, when an eruption is about to happen." The teacher is told to "Look/listen for responses that include rationale describing patterns in the data. Prompt students for more detail on similarities and differences in the data that prompted them to assign a particular data period to a particular warning level. Independent use of the element is expected of students."
- Lesson 3, Session 5: This element is fully claimed as an opportunity for students to demonstrate mastery. Students do a first draft of their summative assessment task,

which asks them to "provide rationale using similarities and differences in the data as evidence." Independent use of the element is expected of students.

- Non-focal element: *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.*
    - Lesson 2, Session 6: This element is partially claimed (although the part used is not specified) as an opportunity for students to work toward mastery. The teacher supports students to develop toward this element: "Pick a piece of evidence. Have students evaluate whether the evidence makes sense in addressing the claim. Use a think-aloud to go over and interpret the evidence. Then, provide a piece of reasoning for the analyzed piece of evidence. Have students evaluate and support why the reasoning is strong, and then practice this skill independently." Later in the session students are asked to argue from evidence to "collect evidence and develop reasoning to support the claim: Some volcanoes are more dangerous than others. Use resources from previous sessions and note the sources of your evidence."
    - Lesson 3, Session 4: This element is fully claimed as an opportunity for students to work toward mastery. Students are asked, "What can we say about data and increased volcanic activity?" The sample student answer says, "When there is increased volcanic activity, the data shows higher values, larger peaks, and a greater number of overlapping peaks." Students are then asked, "How does the historic data support your decision?" The sample student answer says, "We learned from the historic data that [gas levels] are around [number] at [time before eruption]. The patterns in the historic data at [time before eruption] looked similar to [time stamp] in the current dataset. This helped us estimate from the current data how far away a potential eruption might be."
    - Lesson 3, Session 5: This element is partially claimed (although the part used is not specified) as an opportunity for students to demonstrate mastery. Students are asked, "Why should the volcano you selected be high priority for monitoring? Include information about at least four of these factors: Current activity status, Type of volcano, Local populations, Eruptive history, VEI. Provide rationale using similarities and differences in the data as evidence." Teacher-provided scaffolding is not given at this point.

Suggestions for Improvement

Consider clarifying for teachers whether the Lesson 2, Session 6 assessment is to be used as a check on student progress rather than an expectation that all students are already demonstrating full mastery of the SEP element.

OVERALL CATEGORY II SCORE: 3 (0, 1, 2, 3)	
Unit Scoring Guide – Category II	
Criteria A-G	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

III.A. MONITORING 3D STUDENT PERFORMANCES

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena and design solutions. There is a fairly close alignment between learning goals and assessments in the unit, and students produce many individual artifacts of their multidimensional performances. However, the summative assessments are very teacher-driven so students have little opportunity to construct new understanding of the scenario presented.

Related evidence includes:

- Lesson 1, Session 3: Students read about different aspects of how volcanoes change over time, including through chemical changes. Students jigsaw various readings, activities, and simulations, and then share information with each other. They are then asked to use the combined information in sense-making of the scenario “Connor goes to the desert every year on vacation and passes the same sandstone butte. Every year it gets smaller.” Students individually fill out the 3-D Reflect page in their Twig Journals. In this performance students use parts of the following elements:
    - SEP: *Integrate qualitative and/or quantitative scientific and/or technical information in written text with that contained in media and visual displays to clarify claims and findings.*
    - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
    - DCI: *The energy that flows and matter that cycles produce chemical and physical changes in Earth’s materials and living organisms.*
- Lesson 1, Session 5: Students are asked, “What do you think has happened to the rocks that used to be on the volcano in Image 3?...How has your model helped you make that claim?” The student-facing rubric lists a proficient level of performance as including the following: “Student mostly describes the role of the physical model in their description of the processes that cause observable changes in the landscape. Student mostly describes the role of the physical model in explaining the session’s investigative phenomenon” (Different Types of Rocks Student Rubric, page 6). In this performance students use parts of the following elements:
    - SEP: *Develop and/or use a model to predict and/or describe phenomena.*

- CCC: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
- DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*

- Lesson 1, Session 6: Students demonstrate knowledge that phenomena happen at various scales and that some scales are hard to observe. In the session Exit Ticket students are asked, "How can you use your model to explain why some landscape features appear to change while others appear to remain stable?" In this performance students use parts of the following elements:
  - SEP: *Develop and/or use a model to predict and/or describe phenomena.*
  - CCC: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 1, Session 7: Students are asked, "How did Mount Mazama change over its lifetime, When was it relatively stable? Explain the processes involved and whether the changes were fast or slow." The teacher is told to "Ask students to pair up to verbally share their thinking, referring to any visuals as needed. As Student 1 shares, Student 2 should listen carefully and ask for clarity, reasoning, details, and examples that support Student 1's thinking. Students then switch roles." In this performance students use parts of the following elements:
  - SEP: *Respectfully provide and receive critiques about one's explanations, procedures, models, and questions by citing relevant evidence and posing and responding to questions that elicit pertinent elaboration and detail.*
  - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 1, Session 8: In the summative assessment in this session, students are asked to "Develop a landscape model to describe the processes and physical and chemical changes that result in different rock types. Your model should include labels and arrows to show the source(s) and flow of energy and the movement of matter. You should indicate where the rocks from the four locations would have formed. 2. Which of the four locations are volcanoes? Use your model to describe how the landscapes were formed. Be sure to include: How the landscapes changed at different scales, from the atomic to the very large, and over time, How energy drove their formation, How matter was cycled." The proficient level of the scoring rubric says, "Student constructs explanations of stability and change in a landscape by using the model to describe

the changes to rocks over time and the processes that result in these changes at different scales, including the atomic scale" (Hills and Mountains, or Volcanoes? Teacher Rubric, pages 4–5). In this performance students use parts of the following elements:
  - SEP: *Construct an explanation using models or representations.*
  - CCC: *Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and processes at different scales, including the atomic scale.*
  - DCI: *All Earth processes are the result of energy flowing and matter cycling within and among the planet's systems. This energy is derived from the sun and Earth's hot interior. The energy that flows and matter that cycles produce chemical and physical changes in Earth's materials and living organisms.*
- Lesson 3, Session 3: "Are there any times that several data types (seismic, temperature, GPS, and/or gas) peak at the same time? What might this suggest?" The sample student answers say, "Because lots of data is peaking at the same time, an eruption could be approaching." and "There isn't much overlap between the peaks in different data. The peaks seem kind of random, so an eruption is not likely to happen immediately." In this performance students use parts of the following elements:
  - SEP: *Analyze and interpret data to determine similarities and differences in findings.*
  - CCC: *Patterns in rates of change and other numerical relationships can provide information about natural and human designed systems.*
  - DCI: *Understanding of related geologic force, can help forecast the locations and likelihoods of future events.*
- Lesson 3, Sessions 5 and 6: As a summative assessment in the unit, students develop volcano monitoring plans. The task assesses focal learning goals, but it is heavily scaffolded, and does not provide opportunities for students to transfer information to a new scenario or to construct new understanding of the task scenario. Similarly, the Benchmark assessments for the module only require students to use the same scenarios as used throughout the module.

Suggestions for Improvement

Consider providing students with more opportunities to transfer their learning to new phenomena- or problem-based scenarios, allowing students to truly engage in sense-making during formal tasks.

III.B. FORMATIVE	
Embeds formative assessment processes throughout that evaluate student learning to inform instruction.	
Rating for Criterion III.B. Formative	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction. Throughout the module, teachers are supported with ideas for how to respond to student needs and how to modify instruction in relation to all three dimensions. There is also a large variety of formative assessment opportunities, including hands-on (L1-S1, 3, 4, 5, 6, 8; L2-S1, 2, 3, 4) and video/digital labs (L1-S2, 7; L2-S3, 5; L3-S1, 5), think and talk sessions (numerous), and jigsaw tasks.

Throughout the module there are frequent teacher notes about how to respond to student performances. Related evidence includes:

- Lesson 1, Session 2: Students are asked, “How are forces and energy involved in creating volcanoes?” “Interpretation and Response: Look/listen for responses that describe energy being transferred. Prompt students for more detail on the role that energy has in creating volcanoes and how energy might be moving from one place to another.”
- Lesson 1, Session 4: “Look/listen for answers that indicate similarities in the types of forces or processes in the model and natural environment but differences in the scale of these forces or processes. Use talk moves to elicit specific comparisons between Earth processes in the model and the natural environment and reinforce student ideas that while models have limitations, they are useful for representing processes at different scales.”
- Lesson 1, Session 6: “Interpretation and Response: At this point in the lesson, students should be identifying that matter and processes can appear to change or be stable at the atomic scale. If students are only considering stability and change at the landscape scale, prompt them to refer back to examples in the text of changes that happen to particles, atoms, or crystals of rocks.”
- Lesson 1, Session 8: “If students are struggling to identify evidence to support their claim, prompt them to review their Phenomena Trackers and landscape models and consider the investigations that provided the evidence they used to develop their models.”
- Lesson 2, Session 1: “Look/listen for responses that also connect explosivity and amount of lava with the potential danger posed by an eruption. If any students are unsure as to which volcano might be more dangerous, prompt them to reflect on the extremely high temperature of lava and compare the potential effects of a large amount exploding (versus a lesser amount flowing) into the landscape and communities surrounding the volcano.”

- Lesson 2, Session 3: "If needed, clarify that identifying relationships is one way that scientists use patterns to understand phenomena."
- Lesson 3, Session 4: "Support students struggling to write their scientific arguments by providing them with guiding questions: How can this table be used to build a scientific argument? What claim are you making? What evidence from the module supports your claim? Why does your evidence support your claim? This is your reasoning." Note, however, that this guidance is in reference to an assessment that only claims **Analyzing and Interpreting Data** as an assessed SEP, and not **Engaging in Argument from Evidence**.

In the formal formative assessment opportunities, teacher rubrics are provided that suggest next steps. For example:

- Lesson 1, Session 5: "Give students individualized feedback to help them better understand their score on this assessment…..Use the student checklist and rubric to identify and provide actionable feedback on concrete steps students can take to improve their understanding and/or more clearly or fully express their own ideas" (Different Types of Rocks Teacher Rubric, page 7). The teacher rubric document also lists "Suggested strategies for adjusting instruction to support the learning of individual students and whole classes, organized by Rubric Criteria." For example: "Using the physical model to explain the Investigative Phenomenon: Use talk moves from the Vocabulary and Language Guide to facilitate a discussion of how the Rock Riders activity modeled the rock cycle. Prompt students to discuss which real-world processes and features were represented by the locations and actions in the activity, and how the spatial and time scales of the Rock Riders activity can help us explain differences in rocks and land features we observe in nature" (Different Types of Rocks Teacher Rubric, page 9).
- Lesson 1, Session 8: "Modifying Instruction: Suggested strategies for adjusting instruction to support the learning of individual students and whole classes, organized by Rubric Criteria: Developing a model to describe and explain the Investigative Phenomenon and Anchor Phenomenon. In Lesson 2, students will work with physical models of lava from different volcanoes and use this model to explain why some volcanic eruptions are more explosive than others. If students struggled to use their landscape models to explain the Investigative or Anchor Phenomenon, consider providing additional support (including the Developing and Using Models handout) in Lesson 2 Session 3 as students apply learning from their investigation to the volcanic features in the Anchor Phenomenon" (Hills and Mountains, or Volcanoes? Teacher Rubric, page 8).

In the Assessment Tab of the module, a "Scoring and Interpretation" section provides guidance for responding to student needs as determined by the assessment. Note, however, that this guidance is in a separate tab from the teaching instructions, with no direct links from the assessment to the assessment guidance, meaning that it is less likely that teachers would navigate to this guidance. Examples of this guidance include:

- Lesson 1, Session 5: "If student responses do not indicate how energy is involved in processes that change rocks, or if their answers identify that energy is involved but do not describe how, consider guiding students to closely read the 'What's in a Rock?' article in Lesson 1, Session 6 to identify processes that affect rocks, and how energy is involved in those processes."

- Lesson 2, Session 1: "If student responses do not indicate that they analyzed their observations to identify differences in the lava models, prompt them in Lesson 2 Session 2 to analyze the data in Investigation 2: Viscosity of Liquid and describe the similarities and differences in liquid properties and in flow rates."
- Lesson 2, Session 3: "If student answers focus on the relationship between the viscosity and gas content of magma but do not relate this to explosivity, consider providing additional supports for interpreting data using the Analyzing and Interpreting Data handout and Patterns handout. Prompt students to review their responses to the Lesson 2 Session 3 Think Talk before reading the 'Different Volcanoes, Different Eruptions' article in Lesson 2 Session 4."
- Lesson 3, Session 3: "If many students are struggling with analyzing the data to identify patterns, or using patterns from their analysis to make a prediction, consider having students use the PAT-4 graphic organizer in the Patterns handout to analyze and look for patterns in each graph. Then, have them revise their responses."
- Lesson 3, Session 4: "If student responses do not indicate that analyzing multiple types of data at one time allows patterns to emerge, prompt them to return to the data tables in Lesson 3 Session 1. Have students use a piece of paper to cover the three right-hand columns and review the GPS data in isolation. Challenge students to try to identify, based on patterns in the GPS data alone, when the volcano was erupting, then repeat the task again using all of the available data. Then, have them return to revise their exit ticket responses."

Suggestions for Improvement

- Consider ensuring that all formative assessment guidance is aligned with the assessment targets.
- Consider providing guidance for adjusting instruction in reaction to varying types and levels of student responses more often.

III.C. SCORING GUIDANCE

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

Rating for Criterion III.C. Scoring Guidance	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials include an aligned rubric and scoring guidelines that help the educator interpret student performance. Example student answers are provided throughout the module, and assessment targets are provided for all formal assessment opportunities. In addition, several teacher- and student-facing rubrics are provided for varying tasks in the module. However, assessment targets and scoring guidance do not always match student assessment prompts.

Example student responses are provided for the teacher. For example:

- Lesson 1, Session 2: Students are asked, “How are forces and energy involved in creating volcanoes?” Blue text shows the student answers: “Forces cause the plates to move. Energy is transferred to the mantle, causing it to melt.”
- Lesson 2, Session 1: The Exit Ticket prompt is “What do you think determines how explosive an eruption is? Think back to your Merapi and Auckland models.” The exemplar student answer is, “The thicker cola had a more explosive reaction, so thickness of liquid might affect how explosive an eruption is.”

Assessment targets are provided for tasks throughout the unit, and they usually match the students’ assessment prompts. For example:

- Each “3D assessment” in the module lists assessment targets.
- Pre-Assessment: “Question 1a. The model shows the Earth’s outer layers changing over time. How will the land above the continental plate change?....Correct answer: A volcano will form.” The teacher guide states that this question aligns to MS-ESS2-1 (partial), ESS2.A-M1 (partial), and SEP-2.M5 (partial).

Teacher rubrics are provided. Teachers are given the three dimensions of a targeted PE in student-friendly language. However, a range of sample student responses is not provided. The rubric lists four levels of performance for all three dimensions and provides Look Fors. For example:

- Lesson 1, Session 5 includes a teacher rubric.
- Lesson 1, Session 8 includes a teacher rubric.
- Lesson 2, Session 6 includes a teacher rubric. Note, however, that the targeted SEP is **Analyzing and Interpreting Data**, although the assessed student performance is creating an argument from evidence. This might be confusing to teachers, as students use both SEPs. The online version of the Teacher Edition says, “Students write a scientific argument in response to the claim: Some volcanoes are more dangerous than others. They use evidence from the module to support their argument. Part of the proficient level of the rubric says ‘Student provides 3 solid pieces of evidence to support the claim. Each piece of evidence has well supported reasoning that justifies the evidence and supports the claim. Argument is well-written in at least 1 paragraph’” (Dangerous Volcanoes Teacher Rubric).
- Lesson 3, Session 4 includes a teacher rubric. Note, however, that the targeted SEP is **Analyzing and Interpreting Data**, although the assessed student performance is creating an argument from evidence. This might be confusing to teachers, as students use both SEPs. The Teacher Edition says, “Have students use their graphic organizer to write a scientific argument on pages 110–111 in their Twig Journals, justifying why they assigned certain warning levels at particular times.” Part of the proficient level of the rubric says that the students’ argument “includes well

supported reasoning that justifies the evidence and references the historic dataset" (Warning Levels Teacher Rubric).
- Lesson 3, Session 6 includes a teacher rubric.

Scoring rubrics are provided to students in several parts of the unit, helping students to target and monitor their performances. Students are also given the three dimensions of a targeted PE in student-friendly language. The rubrics list four levels of performance for all three dimensions, and the document also tells students "When reviewing your work, your teacher will be looking for the following," and provides a checklist of components to add to their work. Examples include:
- Lesson 1, Session 5 includes a student rubric.
- Lesson 1, Session 8 includes a student rubric.
- Lesson 2, Session 6: Note that the targeted SEP is **Analyzing and Interpreting Data**, although the assessed student performance is creating an argument from evidence. This might be confusing to students, as they need to use both SEPs. The actual student prompt says, "Analyze and interpret the data in the Dangers of Volcanoes handout and on pages 65-66, 67, and 75. Use the patterns that you notice as evidence to support an argument that some volcanoes present a greater hazard than others."
- Lesson 3, Session 4: Note that the targeted SEP is **Analyzing and Interpreting Data**, although the assessed student performance is creating an argument from evidence. This might be confusing to students, as they need to use both SEPs. The actual student prompt says, "Look for similarities and differences as you analyze and interpret the data. Then, use the patterns that you notice to support your rationale for why you provided the warning labels for the volcano on particular days."
- Lesson 3, Session 5: When the summative assessment task is introduced, students are given the rubric against which they will be scored. "Share the Monitoring Volcanoes Student Rubric and explain that you will use this to assess the monitoring plans students will draft today. They will review and present these plans in the next session."

A "Scoring and Interpretation" section is provided in the online assessment tab for some of the assessments in the unit. Indications of elements used in the assessment are also given, but do not clearly state which parts of the elements are targeted. For example:
- Lesson 2, Session 4: Standards: "ESS3.B-M1 (partial), CCC-1.M4 (partial), SEP-4.M7 (partial)." Which parts of the elements are targeted are not indicated. Scoring and Interpretation: "Student answers describing the relationship between viscosity, gas content, and explosivity reflect an understanding of some of the geologic forces that can be used to make predictions about future volcanic events, which is a key component of the middle school-level element of the disciplinary core idea ESS3.B. Look for evidence that students understand the relationship between viscosity, gas content, and explosivity even if they are not using these specific terms."
- Lesson 3, Session 2: In the end of session "3D Reflect" assessment, students are given some information about different equipment and techniques. They are told that a team of meteorologists "want to choose a tool that best measures the amount of rainfall over time so they can identify patterns in the data." To successfully complete the task, students only need

the claimed SEP and CCC elements, but the assessment guide claims that "ESS3.B-M1 (partial)" is also an assessment target.

Two Benchmark Assessments are provided with the module. Benchmark Assessment A includes nine questions, and the scoring guidance only says that each question is automatically scored and is worth one point. Two full CCC categories, two full SEP categories, and two DCI categories are claimed as assessment targets for these nine questions, plus two full NGSS PEs (**MS-ESS2-1** and **MS-ESS3-2**). Scoring rubrics and intended matches between grade-appropriate elements of the three dimensions and the question prompts are not provided. Benchmark Assessment B has the same large scale assessment targets as Benchmark Assessment A, and describes which PEs are the assessment targets for questions 1 and 2, but not for the other questions. However, Benchmark Assessment B is a performance assessment, and provides a scoring rubric for some of the questions. However, example student answers are not provided.

Suggestions for Improvement

- Consider providing sample student responses for performance tasks and for different levels of performance for each of the three dimensions. This could help teachers link assessment targets to concrete, in-context performances.
- Consider ensuring that assessment targets match assessment prompts, especially for the Benchmark Assessments.

III.D. UNBIASED TASK/ITEMS

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples. Assessments in the module often use multiple modalities in both the prompts and in student responses and some on-ramping is provided for the assessments. Students frequently have a choice of modality in their assessment responses.

Related evidence includes:

- The student assessments in the unit are available in both English and Spanish, and in both written and audio format. The vocabulary and reading levels used in assessments are grade appropriate.

- Lesson 1, Session 1: “Exit Ticket questions can be responded to orally or as written responses, digitally or on scratch paper. Questions requiring shorter responses may be especially flexible for allowing students to use a modality of their choosing to express their ideas.”
- Lesson 1, Session 5: In the formal formative assessment, the teacher is told, “Give students the option to present their model and their explanation for how they used the rock’s journey model verbally or in writing. Allow students to point to their landscape models and use gestures to support their descriptions of the processes that caused observable landscape changes, as well as their explanations of how they used the rock’s journey model to understand and describe these processes and explain the investigative phenomenon.”
- Lesson 1, Session 8: In the summative assessment, the teacher is told, “Give students the option to present their model and their claim, evidence, and reasoning verbally or in writing. You may choose to allow students to do this in either digital or in-person formats. Allow students to point to their landscape models, use gestures or diagrams, or make use of the rock samples to support their explanations of the model and the Anchoring Phenomenon.”
- Lesson 2, Session 1: “Exit ticket questions can be responded to orally or as written responses, digitally or on scratch paper. Questions requiring shorter responses may be especially flexible for allowing students to use a modality of their choosing to express their ideas.”
- Lesson 2, Session 5: The teacher is prompted to provide “…multiple means of representation. Provide a visual model of the effects of ash to support student understanding. Place a small pile of flour on black construction paper. Fill a balloon with air, point it at the flour, and release the air. Have students observe how far the flour travels.”
- Lesson 2, Session 6: “Give students the option to develop and present their argument verbally or in writing. You may choose to allow students to do this in either digital or in-person formats. Allow students to point to evidence in their graphic organizers and use drawings and diagrams to support their arguments about the level of danger posed by different volcanoes.”
- Lesson 2, Session 6 and Lesson 3, Session 4: The proficient level of the teacher rubrics include the bullet “Has few or some spelling and grammatical errors.” The “Developing” level of the rubrics say, “Has several spelling and grammatical errors” (Dangerous Volcanoes Teacher Rubric, page 5). However, the corresponding student-facing rubrics do not include any information about spelling and grammar being part of the scoring for the task, so this aspect of the scoring rubric is unfair.
- Lesson 3, Session 1: “Have ELs use gestures, single words, and frame sentences to confirm understanding of the table. ‘I can record the __ in the __ column’.”
- Lesson 3, Session 1: “Students can complete the Phenomena Tracker as a paired or individual written task rather than as a discussion, or as a class discussion rather than peer discussion, depending on student needs and preferences. Allow students to use both text and drawings if completing it as a written task…Exit ticket questions can be responded to orally or as written responses, digitally or on scratch paper. Questions requiring shorter responses may be especially flexible for allowing students to use a modality of their choosing to express their ideas.”
- Lesson 3, Session 4: “Give students the option to develop and present their argument verbally or in writing. You may choose to allow students to do this in either digital or in-person formats.

Allow students to point to evidence in their datasets and graphic organizers and use drawings and the provided visuals to support their arguments of the warning levels warranted at different points in time."

- Lesson 3, Session 5: In preparation for the summative assessment, the teacher is told, "Give students the option to develop and present their monitoring plan verbally or in writing, including text or visual representations. You may choose to allow students to do this in either digital or in-person formats. Allow students to point to evidence in the Undermonitored Volcanoes handout and the graphic organizer on page 112 in the Twig Journal, and create charts and additional diagrams to support their plans to increase monitoring of a particular volcano."
- Benchmark Assessment: There are nine multiple choice questions. The question stems include graphs, photographs, tables, and sketches, as well as drag-and-drop graphics. This is an example of multiple modalities of representation in assessments. Question 1 starts with this on-ramping information: "Scientists travel to two locations in which igneous rocks can be found. They plan to develop a model of the rock cycle using information about both locations." High-quality photographs follow. The initial text, photos, and sketch of different types of rocks in a landscape position all students with the same background information (on-ramping), which decreases any bias associated with differential experiences.

Suggestions for Improvement

As some assessments might take significant time to complete, consider providing guidance to teachers about what to do if there is not enough time for a student to complete an assessment.

III.E. COHERENT ASSESSMENT SYSTEM

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. All four types of assessment are present in the module, and the module's assessment system works together to produce information about student learning. In addition, the module's assessment targets align fairly well overall with its learning goals. However, although teachers are given ample information about the rationale and use of most parts of the module's assessment system, a description of how these system components — and especially the Benchmark Assessments — work together is not provided for teachers.

A "3-D Assessment Suite" is provided with the module that lists and counts the types of assessments used in each Twig module. The document also provides guidance for teachers on using the online version of the module for student assessment (e.g., where to click to view student responses).

Pre-Assessment:

- Lesson 1, Session 1: "Have students complete the Pre-Assessment (Pre-Exploration) on pages 12-14 in their Twig Journals. Students are not yet expected to demonstrate mastery of the PEs. The sample answers show how on-level students might respond. If you identify students underperforming, then consider using the scaffolds in the key sessions where sense-making should occur." However, only a small portion of the learning goals for the module are included in the pre-assessment. Although the assessment itself lists all of the focal SEP, CCC, and DCI categories as assessment targets in the pre-assessment, all of those categories are not actually elicited by the assessment. In addition, the rigor of the pre-assessment is such that teachers would not be able to differentiate between a student who is almost on level and a student who has very little experience with any of the three dimensions. Teachers might therefore not differentiate supports effectively.

Self-Assessment:

- Lesson 1, Session 7: "Give students the opportunity to self-assess their learning by providing time to compare their two responses."
- Lesson 2, Session 3: "Invite students to individually answer the prompt on page 68 in their Twig Journals before working with two to three partners to complete the routine. After students finish, prompt them to revise their written responses on page 68 in their Twig Journals. Give students the opportunity to self-assess their learning by providing time to compare their two responses."
- Lesson 3, Session 2: "Invite students to individually answer the prompt on page 99 in their Twig Journals before working with two to three partners to complete the routine. After students finish, prompt them to revise their written responses on page 99 in their Twig Journals. Give students the opportunity to self-assess their learning by providing time to compare their two responses."

Summative Assessment:

- Lesson 3, Sessions 5 and 6: "In teams, students look at a dataset of undermonitored volcanoes and, considering a number of variables, identify one they think should be monitored more. They create a monitoring plan for their chosen volcano, identifying hazards, monitoring techniques, and the expected data output."
- Two benchmark assessments are provided with the module, but at least one of them (A) seems to rely mostly on vocabulary-based recall items or one-dimensional items. Their use in relation to the other unit assessments is also not described, such as when to use them and for what purpose.

Formative Assessment:

- See related evidence under Criterion III.B.

Suggestions for Improvement

- Consider clarifying for teachers how the various assessments in the unit are meant to work together to help create a full picture of student learning over time.
- Consider updating Benchmark Assessment A to more closely align with the module learning goals.
- Consider providing additional ways to differentiate between levels of students' prior understanding for the pre-assessment.

III.F. OPPORTUNITY TO LEARN

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback.

Rating for Criterion III.F. Opportunity to Learn	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCCs. Throughout the module, students have ample opportunities to demonstrate growth and experience feedback loops related to focal elements of all three dimensions.

Related evidence includes:

- For each focal element in the unit, students have multiple opportunities to practice the element in different contexts and to show their growth on multiple assessments over time. See related evidence under Criterion I.B.
- Lesson 1, Session 1: The teacher is told to "Circulate as students generate ideas of methods they might use to model different processes. If needed, remind students that they explored some of these processes in Session 3. Prompt students to explain, in their own words, how a process in their model might change the crayons, and how this process relates to a real-world process that changes rocks. Offer feedback to students on their explanation of how their chosen processes model the geological processes they learned about in Session 3, and on students' identification of forces and energy transfers as part of those processes." In this case, students receive feedback on focal elements of all three dimensions. Students use and develop these elements in several lessons, receive feedback on their use of them in Lesson 1, Session 4, and then use the elements again in later lessons.

- Lesson 2, Session 2: “Circulate as students discuss their findings in pairs or groups. As this is the first session in Volcano Hunters in which students will be working toward mastery of the CCC-1.M4 element, provide feedback on their identification of patterns in their data and possible relationships between the liquid’s flow rate and the other tested variables.”
- Lesson 3, Session 1: Teachers are told, “When providing feedback, look and listen for student language that demonstrates conceptual understanding of these tools and data types rather than correct use of the names of the tools… Circulate as students pair-share to discuss their responses. Remind students, as needed, that their goal is to analyze their graphs to identify patterns between values in the data and the timing of eruptions. Provide feedback to students on their analysis of both their tables and graphs, and their identification of similarities and differences between data from different sources.” Then in Lesson 3, Session 3, the teacher is told to “Circulate to support scientific discussion, using talk moves to elicit evidence and help expand and clarify student thinking. Provide feedback on the students’ analysis and interpretation of the data (including their identification of similarities and differences between data from different sources), and their use of their graphs as evidence to support their answers.” In both of these cases, students receive feedback on a focal SEP element on which they later have opportunities to demonstrate their growth.
- Lesson 3, Session 5: In preparation for the module’s summative assessment, students are told, “You will be assessed on the monitoring plans you draft today, and review and present tomorrow” (slide 79). “You will have the opportunity to review and update your plans at the beginning of the next session” (slide 80). Students therefore have an opportunity to revise their work before they are scored on it.

Suggestions for Improvement

Consider developing concrete measures of growth that teachers can recognize and use to assess students’ growth over time in all focal learning targets.

OVERALL CATEGORY III SCORE: **3** (0, 1, 2, 3)	
Unit Scoring Guide – Category III	
Criteria A-F	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

Scoring Guides for Each Category

Unit Scoring Guide – Category I (Criteria A-F)	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Unit Scoring Guide – Category II (Criteria A-G)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Unit Scoring Guide – Category III (Criteria A-F)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Volcano Hunters

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL SCORING GUIDE	
E	**Example of high quality NGSS design—**High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9)
E/I	**Example of high quality NGSS design if Improved—**Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7)
R	**Revision needed—**Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5)
N	**Not ready to review**—Not designed for the NGSS; does not meet criteria (total 0–2)