Unit 2: Glassblowing

DEVELOPER: Carolina

GRADE: 2 **|** **DATE OF REVIEW:** April 2021

Glassblowing

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

Glassblowing

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 three-dimensional learning, connecting assessments to all three dimensions, eliciting student ideas, and giving students many opportunities to receive and react to feedback. The unit also has detailed and thorough guidance for educators, and individual lesson pages are structured with a one-to-one match between instructional steps and purple educator guidance.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Ensuring that student Science and Engineering Practice (SEP) expectations are grade-appropriate.** Currently, the major assessment opportunities in the unit rely on students' use of SEPs from the middle school level, especially **Developing Models** and **Constructing Explanations**. Adjusting expectations and student prompts would increase the strength of the unit.
- **Providing example student work**. Assessment and scoring guidance are currently provided but could be interpreted differently by different people. Example student work — including multiple samples that show a range of student proficiency for each of the major assessment opportunities — would help clarify the intended level of performance for each dimension.
- **Energy and Matter Crosscutting Concepts (CCCs).** Although the materials are effective at addressing the building up of a set of small pieces into something new or larger, the materials do not fully or meaningfully address the breaking apart of a larger object to produce the small pieces that are then used to make something new. The beginning of the glassblowing phenomenon video shows larger shapes of clear glass products being smashed and combined. Pausing the video there to facilitate students in making observations of and asking questions about the origins of the set of small pieces (broken large products) could make this CCC element more obvious.

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 the criterion was not met. Unless otherwise specified, page numbers in the document refer to the page numbers listed on the teacher guide.

CATEGORY I

NGSS 3D DESIGN

Glassblowing

EQuIP RUBRIC FOR SCIENCE EVALUATION

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	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that learning is driven by students making sense of phenomena because the focus of the lessons in combination with one another is to support students in progressively making sense of an anchor phenomenon. The phenomenon connects closely with grade-appropriate DCI learning goals, and students' questions related to the phenomenon motivate sense-making.

True phenomena drive sense-making in the unit and students return to the anchor phenomenon frequently to add to their explanations. For example:

- The teacher is told that the previous unit is based on answering the question, "Our planet is filling up with large piles of trash. What can we do to help solve this problem?" This problem is not used to drive learning in this unit.
- The unit driving question is "How can objects change into other objects?" (PDF, page 5).
- Anchor and investigative phenomena are listed for each lesson (PDF, pages 14–18).
- Lesson 1: "Say, 'Last night, I accidentally broke a drinking glass during dinner. I carefully cleaned up my mess and was getting ready to throw the pieces of glass away, but I started thinking about Unit 1 and how we came up with different solutions for reducing what we throw away. I wondered whether there might be a way to reuse the pieces of broken glass. I even thought that I might be able to make something new out of them.' Ask, 'How do you think I could reuse the pieces of broken glass? I will give you a couple of minutes to think about this before we discuss everyone's ideas.' Have students to[sic] spend a minute or two brainstorming ways to reuse the glass pieces and then discuss their ideas with a partner. Once students feel comfortable with their ideas, facilitate a class discussion. As students share, record their ideas on the Ways to Reuse Glass chart" (Lesson 1, page 8). Students then watch a video that shows the anchor phenomenon: "pieces of broken glass are heated and shaped into a colorful pitcher" (Lesson 1, page 9).
- Lesson 1: "Play Digital Resource: The Art of Glassblowing Video for the students again. Ask them to focus on important events or steps that occur in the glassblowing process and why they think these steps are important. After playing the video, facilitate a brief discussion for the class to try to make sense of what they observed. Have students share and discuss their ideas about which events or steps in the glassblowing process are important and why they think so" (Lesson 1, page 13).

- Lesson 1: "Facilitate a class discussion for students to come to a consensus about what [sic] think is happening during this event. Determine the following and record the overall consensus for each question on the chart: What happened to the pieces of glass during this event? Why do we think this happened? … What are we unsure of? How could we show on our model that we are not sure about an idea?" (Lesson 1, page 20).
- Lesson 2: Students work to explain the anchor phenomenon and observe a new investigative phenomenon, "The observable properties of the glass marbles may or may not change when the marbles are heated to different temperatures" (e.g., Lesson 2, page 14).
- At the end of each lesson, students return to the anchor phenomenon. For example:
    - Lesson 2: "Direct students' attention to the Class Consensus Model from Lesson 1. Focus on the section that displays the pieces of glass being heated in the furnace. Review the class' initial ideas about the glass pieces in the furnace. Facilitate a class discussion for students to determine how they would update this portion of the model using the new ideas they formed during this lesson. Make any changes to the model that the class agrees on" (Lesson 2, page 22).
    - Lesson 3: "Direct students' attention to the Class Consensus Model. Ask students to identify the sections of the glassblowing story they can now explain using evidence from their investigations. If time permits, have students identify which questions on the model they can now answer. After the class explains an answer for the question, place a large checkmark on the sticky note to symbolize that the question has been answered" (Lesson 3, page 38).
- Lesson 3: Students make observations of investigative phenomena: "some types of matter change into a liquid (effect) when heated (cause)" (Lesson 3, page 18). Later in the lesson, the teacher is told, "Facilitate a class discussion to further student sensemaking. Say, 'At the beginning of the lesson, we decided that we wanted to figure out if heat, or higher temperatures, affected different types of matter. How would you describe how each type of matter changed when it was heated?'" (Lesson 3, page 30).
- Lesson 3: At the end of the lesson, the teacher is told, "Direct students to the Initial Ideas Class Chart from Part A. Have students individually reflect on how their understanding about the pole has changed since this chart was created, and then allow time for them to share their thoughts with a partner. After time to reflect and share, further sensemaking by facilitating a class discussion in which students to come to a consensus about which ideas from this chart they still agree with and which ideas they now disagree with" (Lesson 3, page 36).
- Lesson 4: Students begin the lesson by observing a new investigative phenomenon — the effects of cooling on their investigative materials from the previous lesson (Lesson 4, page 11).
- Lesson 4: "Students should work together to list ideas for how they can test both high and low temperatures using the materials from their previous investigations. A cooler of ice or a freezer are great options for this investigation" (Lesson 4, page 19).
- Lesson 4: After student investigations, the teacher is told, "Ask, 'How does what we just investigated relate to what we saw the artist doing during the section of the anchoring phenomenon we watched at the start of this lesson?'" (Lesson 4, page 33).
- Lesson 4: After class analysis discussions, the teacher is told, "As a class, have students agree on an explanation about how these patterns can be used as evidence to describe the anchoring phenomenon and explain why the artist keeps putting the unfinished glass glob back into the furnace" (Lesson 4, page 42).
- Lesson 5: "During this lesson, students experience an investigative phenomenon: when wax or crayon pieces are heated, they come together and change shape" (Lesson 5, page 2).

- Lesson 5: After students discuss patterns in how materials behave allowing them to find out what something is made of the teacher is told, “Prompt students to think about the colorful pieces in the anchoring phenomenon again. Say, ‘I wonder what you think the artist’s colored pieces are made of’” (Lesson 5, page 16).
- Lesson 5: “Play Digital Resource: The Art of Glassblowing Video to revisit the anchoring phenomenon as a class. Have students reflect on how their ideas and understanding have changed since the beginning of the unit” (Lesson 5, page 21). “Say, ‘It sounds like you understand a lot more about glassmaking. I think you might be ready to add to your explanation of how the artist made the colorful pitcher.’ Display the ‘Gotta Have’ chart you prepared, and ask students what ideas they think a good explanation must include. Use students’ language to list four or five statements related to the ideas developed during Lessons 4 and 5” (Lesson 5, page 22).
- Lesson 7: “Play Digital Resource: The Art of Glassblowing Video to revisit the anchoring phenomenon as a class. Facilitate a discussion about pieces of glass and the artist. Use questions to prompt students to consider if the changes caused by heating the glass pieces are reversible or not” (Lesson 7, page 7).
- Lesson 7: “Help students use ideas developed throughout the unit to explain any missing processes and make connections to explanations they developed in previous lessons. For example, the artist used metal tools to shape the spout and the observed properties of the metal did not change because temperatures were not high enough” (Lesson 7, page 8).

Student questions about the phenomenon drive almost all the learning and students have frequent opportunities to feel as if they are driving their learning. For example:

- At the end of each lesson, student questions are returned to. For instance, in Lesson 2: “Once the class has revised their initial ideas, have students identify which of their questions on the model they can now answer. After students answer a question, write a checkmark on the sticky note to symbolize that the question has been answered” (Lesson 2, page 22).
- Lesson 1: Students are asked to watch the glassblowing phenomenon video a second time, focusing on what they wonder about what they see in the video. They record questions about what they wonder in their notebooks and share with a partner. Sentence stems are provided to help students ask questions (Lesson 1, page 9). Class questions are recorded on the class “notice and wonder” board and the teacher is given directions about which kinds of student questions to focus on in the class discussion (Lesson 1, page 10).
- Lesson 1: The teacher is told to say, “We have many good ideas about what we think is happening in the anchoring phenomenon. We also seem to be unsure of some of the things we observed. Next time, we are going to develop some questions we have about the events we just described. These questions might help us figure out a way to gather evidence to see if our initial ideas are correct or help us figure out some of the parts of the model we are unsure of” (Lesson 1, page 21).
- Lesson 1: “Have students turn to a blank page in their science notebooks. Prompt students to title the page, ‘Questions I Have About the Anchoring Phenomenon.’” Students are given three prompts to respond to to help create a list of questions, including “How can you take these interests and experiences and change them into a question that begins with ‘who,’ ‘what,’ ‘when,’ ‘where,’ ‘why’, or ‘how’?” The teacher is told in a sidebar, “Students’ questions should be related to their own interests in and personal experiences with the anchoring phenomenon or analogous phenomena. Have students reference their own personal experiences, the Class Consensus Model, Student Artifact 1.1, the Notice and Wonder Chart, and the Similar

Experiences chart for inspiration" and example prompts are given for helping students who struggle with asking questions (Lesson 1, page 23).

- Lesson 1: The teacher is given guidance about eliciting and organizing questions from all students, including: "Facilitate a class discussion for each student to share their selected question. Once a question is shared, have that student place the sticky note directly on the Class Consensus Model. The sticky note should be placed on the chart paper that represents the event the question is about" (Lesson 1, page 24).
- Lesson 1: Discussion and facilitation prompts are given for getting students to come up with or own an overall unit driving question. For example: "Unit driving questions are challenging for students to create because they need to be broad enough to encompass many different ideas. To help focus students' attention, point out the two images that bookend the Class Consensus Model. Have students practice asking questions that relate to these two events" (Lesson 1, page 25).
- Lesson 1: "Explain that now the class needs to decide what event from the Class Consensus Model they should investigate first. Refer to the model and say, 'We have recorded quite the story about glassblowing, including our initial ideas about some of glassblowing's major events. What should we investigate first about the anchoring phenomenon?' Provide time for students to think about and share their ideas. End the discussion by saying, 'It looks like we have a lot to figure out, but many of you are asking about the oven, which is the first event we described in our model. Do you think the oven might be a good place to start investigating?'" (Lesson 1, page 25).
- Lesson 2: Students watch a video clip and are asked to develop specific, potentially investigable questions about the video. The teacher is told, "After each student has shared at least one question, say, 'These are all wonderful questions! It seems like most of us want to know why the artist put the pieces of glass into the oven. Unfortunately, we don't have an oven to investigate with. Can you think of another way we could use heat to test some of our questions?' Leverage students' questions and ideas about different ways to use heat by having the class collaboratively create a question they could investigate in the classroom. Guide students to use the lens of cause and effect to create this question so that they arrive at a question similar to the following: How do different heat sources affect glass?" (Lesson 2, page 9). Facilitation support for this step is provided, including sample prompts. After students brainstorm investigation methods, the teacher is told to say, "It sounds like you all have some great ideas about how to investigate our question. Let me see what types of materials I can gather so we can test some of these ideas during the next class session" (Lesson 2, page 10).
- Lesson 2: At the end of the lesson, "Direct students' attention back to the Class Consensus Model. Say, 'We have figured out why the artist needed a hot furnace. What question about the glassblowing process do you think makes the most sense to investigate next?' Provide time for students to share their ideas, and then say, 'Okay, those are all great ideas. I heard someone mention that next in the process, the artist moves the glass out of the furnace using a pole. Someone else mentioned that they want to know why the pole doesn't melt in the furnace. Since we were just investigating heating and melting, does it make sense to investigate the pole and why it does not melt next?'" (Lesson 2, page 24).
- Lesson 3: "Have the class brainstorm ways they could test their initial ideas about the pole. Records[sic] their ideas on the Testing Our Ideas Class Chart you prepared. Leave space near the top to record the testable question the class comes up with during the next step" (Lesson 3, page 13). The teacher is told, "Help students consider why it is important to gather evidence for several types of matter rather than just the one they think the pole is made of" and given several student prompts. After students identify different types of matter to test, the teacher is

told, “Say, ‘Let me see if I can gather examples of these types of matter for the next time we meet so that we can test these materials to see how heat affects them’” (Lesson 3, page 14). However, the lesson then moves to be teacher directed and not explicitly connected back to the student-developed investigation plan. “Distribute a bag of objects to each group. Explain that they will identify each object’s observable properties and sort the objects by type of matter” (Lesson 3, page 14). “Explain that students will work together in small groups to plan an investigation to test how heat affects some of the materials they sorted” (Lesson 3, page 15).

- Lesson 3: “Say, ‘It sounds like many of us think that making the temperature higher could affect plastic, wood, and metal objects, like it did with glass. What are some ways we might be able to test or get information about how higher temperatures affect these types of matter?’” (Lesson 3, page 23).
- Lesson 3: “Facilitate a class discussion to review what students uncovered during the last class session and what they decided they still need to figure out. As needed, use the following prompts: Who can explain what we discovered during the clamp lamp investigation? Who can remind us what we decided we still need to figure out as part of today’s investigation?” (Lesson 3, page 27).
- Lesson 3: “Ask students to use the Class Consensus Model to decide what about the glassblowing process they should investigate next. As students share and discuss ideas, prompt students to articulate any new questions they have. Have students record any questions on sticky notes, share them with the class, and place them in the appropriate sections of the Class Consensus Model” (Lesson 3, page 39). The teacher is told, “Ensure that students’ questions are driving learning into the next lesson…. The goal of this discussion is for students to want to figure out why the artist keeps moving the glass into and out of the furnace. Questions related to this topic will drive students toward Lesson 4. Suggested prompts: What makes the most sense for us to investigate next, so we don’t jump around in our glassblowing story?”
- Lesson 4: At the end of the lesson, the teacher is told, “Students should feel as if their questions are driving their learning during this unit and in this discussion; however, you are actually guiding them as needed in the direction they need to go. … The goal of this discussion is for students to want to figure out what the colorful pieces are and what happens to them during the glassblowing process. Students may point out that how the colorful pieces change when heated and cooled could provide evidence for what type of matter they are made of. Use the following suggested prompts as needed to facilitate the discussion and guide students toward Lesson 5” (Lesson 4, page 49). A class consensus investigation question is determined.
- Lesson 5: “Ask students to use the Class Consensus Model to decide what they should investigate next in the glassblowing process. During this discussion, prompt students to articulate any new questions they have. Have students record any questions on sticky notes, share them with the class, and place them in the appropriate sections of the Class Consensus Model” (Lesson 5, page 23). On the same page, the teacher is also told, “Ensure that students’ questions are driving their learning into the next lesson. Utilize the logical progression of images on the Class Consensus Model to help students understand that after the artist added pieces of colored glass to the glob, he blew into the pole.” The teacher may interpret this last sentence as being a way to push for a certain next step rather than using student questions.
- Lesson 6: “As a class, develop an investigable question such as, ‘How does blowing air change other objects?’ ... Because they can’t blow into the pole seen in the anchoring phenomenon, students should realize that they need to develop a question that they can answer through investigation” (Lesson 6, page 10). “Prompt students to brainstorm materials they could use to investigate the class question. Record students’ ideas on the ‘Initial Ideas’ chart. If students

don’t suggest bubbles or soapy water, ask if they could be used, and add them to the chart” (Lesson 6, page 11).
- Lesson 6: At the end of the lesson, the teacher is told, “Help students anticipate the next lesson in the storyline. Say, ‘Wow, it sounds like you really understand what the artist was doing. I think you are ready to answer the unit driving question on our Class Consensus Model (e.g., How do objects change into other objects?)’” (Lesson 6, page 21).

Extensive guidance is provided for making connections between the phenomena and students’ prior experiences. For example:

- Lesson 1: The teacher is told, “Encourage students to make a meaningful connection to the anchoring phenomenon by asking the following questions: Where have you seen something like this before? Does something you saw in the anchoring phenomenon remind you of anything you’ve experienced in your life? Record the connections students share on the ‘Connections to the Anchor’ chart” (Lesson 1, page 12). Example analogous phenomena are given.
- Lesson 1: The teacher is told, “Have students identify analogous phenomena from their homes, neighborhoods, communities, or cultures that relate to the events from the anchoring phenomenon. Encourage students to use the lens of energy and matter and the science idea that objects can be broken apart and put together to create something new by considering ways they have built new objects from smaller pieces. Invite students to share these ideas along with other similar experiences to the events with the class and document them on the Similar Experiences chart” (Lesson 1 page 21). However, this “Similar Experiences Chart” is not revisited again in the unit. Therefore, there isn’t evidence that it motivates sense-making.
- Lesson 2: Students watch a video clip, and the teacher is told, “Have students share any prior knowledge or personal experiences they have with what they saw in this video clip by asking: Have you ever seen broken glass? Where was it? How did it happen? Have you ever seen glass put into an oven? Where were you? What did the glass look like?” (Lesson 2, page 8).
- Lesson 2: “Have students describe any prior experiences they have with using numbers to describe how hot something is” (Lesson 2, page 16).
- Lesson 2: “Have students further engage in sensemaking by asking them to identify and describe personal experiences that can explain the idea that higher temperatures can cause changes to an observable property in some type of matter” (Lesson 2, page 23).
- Lesson 3: “Have students use their knowledge from Unit 1 to identify the different types of matter they need to investigate” (Lesson 3, page 14).
- Lesson 3: “Deepen students’ understanding of the word ‘melt’ by bringing personal relevancy to the word. Ask, ‘What other experiences do you have with melting?’” (Lesson 3, page 19).
- Lesson 3: “Have students make a connection between higher temperatures and changes to matter by identifying analogous phenomena from their everyday lives. Ask, ‘Who can share an example of when they observed a certain temperature affecting one type of matter but not another?’” (Lesson 3, page 36).
- Lesson 4: “Provide a few minutes for students to think quietly about how what they noticed relates to something they have already learned about or experienced in their own lives. Next, invite students to explain this connection and place their Notice sticky note on the Notice and Wonder T-chart you prepared” (Lesson 4, page 17).
- Lesson 4: “Have students share experiences they have with something reversing or changing back, such as a lake freezing in winter and thawing in spring, or melted ice cream freezing solid again when it is put back in the freezer” (Lesson 4, page 27).
- Lesson 4: “Have students share a pattern they have seen or experienced in their everyday life. After they share, ask students to answer the question in Step 3 of the Looking for Patterns

section of Student Artifact 4.2 by using their understanding of patterns to explain how patterns can help you make predictions" (Lesson 4, page 31).

- Lesson 4: "Have students share with a partner any experience they have had with putting something back into a heat source and why they did it. Students may describe experiences like the following: I put my marshmallow back in the campfire because it wasn't quite done" (Lesson 4, page 33).
- Lesson 5: Students are asked to identify analogous phenomena, and then the teacher is told, "Use guiding questions to help students describe what fills the objects they identified as analogous phenomena. Is there something inside the balloon?" (Lesson 5, page 10).
- Lesson 6: "Ask students to apply prior experience and ideas developed during the unit to make a prediction individually about will happen if you blow air into the balloon" (Lesson 6, page 19).

Suggestions for Improvement

- Currently, student sense-making is framed using the order of events in the video presented to them. It could be helpful to elicit student ideas about the events separately before they see the video. For example, individual or small groups of students could be given pictures of each step in the glassblowing process and be asked to sort the images into an order they think represents the correct sequence. Prior to exposure to the phenomenon video, students could compare how they ordered the images to ask questions about the images themselves without being influenced by a pre-determined set of steps. This may help to increase student curiosity, elicit a wider range of student questions, and reveal more misconceptions. This would also allow watching the video to answer a question that students have ("Which order do these pictures go in?").
- Consider adding guidance to support the teacher in facilitating students to make connections between their personal experiences and the class sense-making (rather than only the phenomena). For example, the teacher could ask, "Do you think any of your personal experiences could help us figure out ____?"
- Consider expanding reference to and use of the "Similar Experiences Chart" throughout the unit. It could be made into a living document where students add to each time the unit materials prompt the teacher to support students in making personal connections.
- In Lesson 3, consider explicitly connecting the investigation directions back to students' decisions about what to test and how.

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 because there is a reasonable match between the student learning goals claimed and the evidence of student engagement to use and develop the elements of each dimension. Unit and lesson level front matter incorporates strikethroughs to indicate portions of elements not being addressed at certain times. However, the unit materials do not explicitly distinguish between elements that are fully used, elements that are partially used, elements that are fully developed, and elements that are partially developed. In addition, several instances of student use of SEPs are above the K–2 level.

Science and Engineering Practices (SEPs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the SEPs in this unit because although students have extensive opportunities to use and develop SEP elements, the unit includes many instances of students' SEP expectations above the K–2 level, especially for modeling and explanations.

Asking Questions and Defining Problems

- *Ask questions based on observations to find more information about the natural and/or designed world(s).*
    - Lesson 1: This element is claimed in the lesson. Students are asked to record their questions generated from watching the phenomenon video, and sentence stems are provided to help them ask questions (Lesson 1, page 9). Later in the lesson, students are prompted to start their questions with "who, what, when, where, why, or how" and the teacher is given prompts to help students who struggle with asking questions.

Developing and Using Models

- *Distinguish between a model and the actual object, process, and/or events the model represents.*
    - This element is claimed in the unit but not in individual lessons.
    - Lesson 6: Students build toward this element through discussions of a balloon as a model. For example, the teacher asks, "What part of this model represents the transparent glob of glass? The balloon represents the transparent glass" (Lesson 6, page 19).

- *Compare models to identify common features and differences.*
    - Lesson 2: This element is claimed in the lesson. Students compare and contrast models developed by their peers to models they developed themselves. "Partners share, compare, and provide peer feedback on each other's models" (Lesson 2, page 3).
    - Although not claimed, this element is also used in the following lessons:
        - Lesson 1: "After sharing their models, have students compare and contrast their models with their partner using some or all of the following prompts…" (Lesson 1, page 15).
        - Lesson 5: "Discourse: Prompt students to consider similarities and differences among the models all the groups developed. Prompting Questions: Do our models have common features? *(Many of our models use crayons to represent colored pieces.)* Do our models have differences? *(Some groups are using a clamp lamp to represent the furnace. Others are using hot water.)*" (Lesson 5, page 12).
        - Lesson 7: "Turn-and-Talk: Have students individually compare their initial explanatory model (Student Artifact 1.1) with their final, three-part explanatory model. Ask students to identify common features and differences then turn and talk about them with a partner" (Lesson 7, page 15).
- *Develop and~~/or~~ use a model to represent ~~amounts,~~ relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).*
    - Lesson 1: Part of this element is claimed in the lesson. In the lesson pre-assessment, the teacher is told that students are not assessed on modeling but is told to tell the students "Explain that students will make a model that tells the story of how the pitcher was made from many pieces of broken glass. To do this, they need to arrange the images in the order in which they observed them in the anchoring phenomenon" and "Encourage students to make their thinking visible by adding details to explain what is happening to the pieces of glass during each event they sequenced in their model" (Lesson 1, page 14). It is possible that teachers could interpret these instructions to expect students to use a Grade 3–5-level element: *Develop and/or use models to describe ~~and/or predict~~ phenomena.*
    - Lesson 3: Part of this element is claimed in the lesson. Students are introduced to a simulation as a type of model. The teacher is told to say, "Scientists use models like this simulation to represent processes and objects that are too difficult to study first-hand (e.g., too small, too unsafe, too far away). This simulation will help us safely observe what happens to objects that are placed in the artist's furnace" (Lesson 3, page 27). However, this introduces a Grade 6–8-level CCC concept: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small.*
    - Lesson 4: Part of this element is claimed in the lesson. Students are directed to "use a simulation as a model" (Lesson 4, page 36). The students are explicitly told how scientists use simulations as models (repeating the middle school-level concept given in the previous lesson).
    - Lesson 5: Part of this element is claimed in the lesson. "Explain that scientists can also develop their own models, and that the models scientists create don't have to use computers. Scientists develop models that use physical materials. Suggest that developing a physical model of what the artist is doing could help students represent their ideas and questions about the colored pieces. Explain that students will work in small groups to develop a model for the objects and processes the artist used" (Lesson

5, page 10). In the lesson students are supported to choose materials to make physical models of the anchor phenomenon, which they use to represent various steps of the anchor phenomenon process (Lesson 5, page 12). It is possible that teachers could interpret these instructions to expect students to use a Grade 3–5-level element: *Develop and/or use models to describe ~~and/or predict~~ phenomena.*

Planning and Carrying Out Investigations

- *Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence to answer a question.*
  - Lesson 2: This element is claimed in the lesson. The class collaboratively discusses investigation plans in the lesson.
    - "Have students brainstorm with a partner about how they could investigate the class' question" (Lesson 2, page 10).
    - "Have students explain to a partner why they chose the three heat sources they did. Next, have pairs consider specific ways they could use a particular heat source they chose to investigate the question, "How does heat affect the properties of glass?" (Lesson 2, page 12).
    - "Bring the class together to share investigation ideas. Collaboratively develop a simple test for each heat source that will allow students to gather evidence about how heat affects the properties of glass" (Lesson 2, page 13).
    - "How many marbles should we use for each test? (Guide students to control variables in their test plans by deciding to use the same number of marbles for each heat source.)" (Lesson 2, page 13). The idea of controls in experiments is not expected of all students at the Grade 2 level.
  - Lesson 3: This element is claimed in the lesson. Students work in small groups to plan their investigations using scaffolding from worksheets. The investigations are focused on answering the lesson question.
  - Lesson 4: Part of this element is claimed in the lesson. Students work in groups to plan an investigation. The teacher is told, "Listen for students to describe what to test and how to test the effects of heating and cooling on different types of matter. If students don't discuss this, help them consider why it is important to gather evidence for different types of matter rather than just one type" (Lesson 4, page 20).
  - Lesson 5: This element is claimed in the lesson. Students are supported to choose materials to make physical models of the anchor phenomenon. However, this is labeled as **Planning and Carrying Out Investigations** (Lesson 5, page 12) rather than modeling, which may be confusing for students and teachers. Making and manipulating a self-made physical model (representing an object and process) is not an investigation (as it is called throughout the lesson).
  - Lesson 6: This element is claimed in the lesson. "Students build on experiences with planning investigations from previous lessons and progress to planning investigations that include measurement" (Lesson 6, page 12). Later in the lesson, the teacher is told, "Have students state the questions they were trying to answer and briefly recap their investigation from Part B" (Lesson 6, page 18).
- *Make observations (firsthand or from media) and/or make measurements to collect data that can be used to make comparisons.*
  - Lesson 2: Part of this element is claimed in the lesson. Students make observations of the effects of different amounts of heating on marbles. Note that the teacher prompts

for student analysis after the investigations (Lesson 2, page 16) relate to analyzing data, although they are listed under the heading "Planning and Carrying Out Investigations."
    - Lesson 3: Part of this element is claimed in the lesson. Students make and record observations from their investigations and make comparisons between the observations.
    - Lesson 4: Part of this element is claimed in the lesson. Students conduct investigations, making observations and comparisons. The teacher is told, "Guide students to recognize that the class should be able to identify patterns in results even though each group has developed a different investigation procedure for an assortment of objects" (Lesson 4, page 21).
    - Lesson 5: This element is claimed in the lesson. However, students only make observations of their own physical models (representations of an object and process), so these are not scientific observations.
    - Lesson 6: This element is claimed in the lesson. Students make observations and measurements to record data (Student Artifact 6.1).
- *Make predictions based on prior experiences.*
    - Lesson 2: This element is claimed in the lesson. "Encourage students to use prior knowledge or personal experiences to make predictions individually about the effect these heat sources could have on the glass marbles. Say, 'Remember, a prediction is what you think will happen. It is okay if your prediction ends up being incorrect. Use what you already know about these materials to help you make predictions about how your heat sources will affect the glass marbles'" (Lesson 2 page 14).
    - Lesson 4: This element is not claimed in the lesson but is explicitly supported. Students make predictions and the teacher is told, "Remind students that a prediction is a statement about a future event that is made using their experience and knowledge" (Lesson 4, page 22).

Analyzing and Interpreting Data

- *Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.*
    - This element is not claimed in the unit, but it is used by students. For example:
        - Lesson 2: Students "analyze the evidence collected in the class 'Marble Observations' table to compare how the different heat sources (temperatures) affected the glass marbles" (Lesson 2, page 16). Teacher prompts to help students analyze data are also listed but are grouped under a "Planning and Carrying Out Investigations" header, which may be confusing to teachers.
        - Lesson 4: Students fill out an "Analyze Data" chart and the teacher is told, "Underline the word 'analyze' on the Analyze Data chart and explain that 'analyze' means to look very closely at something, like data, to notice things that are not always easy to see, like patterns. Have students review the data for one type of matter from the Clamp Lamp Observations Class Data Table and compare it to the observations for that same type of matter in Table 1 on Student Artifact 4.1 and Tables 1 and 2 on Student Artifact 4.2" (Lesson 4, page 28).

Constructing Explanations and Designing Solutions

- *Use information from observations (first-hand and from media) to construct an evidence-based account for natural phenomena.*
    - Lesson 1: Part of this element is claimed in the lesson. Students create individual and then class sequences of what they observed in the anchor phenomenon video (Lesson 1, page 20).
    - Lesson 3: This element is claimed in the lesson. Students "use models, drawing, writing, or numbers to develop an explanation for the beginning events of the anchoring phenomenon. Students explain how heat affects different types of matter by completing Student Artifact 3.3" (Lesson 3, page 40). The scoring guidance for this performance says, "Student's explanatory model includes drawings and accurately uses cause-and-effect statements or labels and any other labels that enhance their explanation of the anchoring phenomenon." This could be interpreted as students using this Grade 6–8-level SEP element: *Construct an explanation using models or representations,* and examples of proficient student performance are not provided to ensure that teachers will not have above grade-level expectations of all students.
    - Lesson 5: This element is claimed in the lesson. "Students use models, drawings, writing, or numbers to develop an explanation for the middle events of the anchoring phenomenon" (Lesson 5, page 25). The scoring guidance for this performance says, "Student's explanatory model includes drawings, an accurate description of matter coming together as a larger object and changing shape, and additional labels that enhance their explanation of the anchoring phenomenon." This could be interpreted as students using the Grade 6–8-level SEP element: *Construct an explanation using models or representations,* and examples of proficient student performance are not provided to ensure that teachers will not have above grade-level expectations of all students.
    - Lesson 7: This element is claimed in the lesson. "Students use models, drawings, writing, or numbers to develop an explanation for remaining events in the anchoring phenomenon" (Lesson 7, page 13). The scoring guidance for this performance says, "Student's explanatory model includes drawings, accurately describes processes that changed the size and shape of glass objects, and includes additional labels that enhance their explanation of the anchoring phenomenon." This could be interpreted as students using this Grade 6–8-level SEP element: *Construct an explanation using models or representations,* and examples of proficient student performance are not provided to ensure that teachers will not have above grade-level expectations of all students.

Engaging in Argument from Evidence

- *Construct an argument with evidence to support a claim.*
    - Lesson 4: Part of this element is claimed in the lesson. Students are introduced to argumentation through teacher examples and heavy scaffolding from student activity sheets.
    - Lesson 5: This element is claimed in the lesson. "Students fill in the graphic organizer individually to make a claim and support it with relevant evidence and reasoning from unit investigations" (Lesson 5, page 17).
    - Lesson 6: This element is claimed in the lesson. Students are given sentence starters to scaffold their arguments. The teacher is told, "Invite students to share their claim, evidence, and reasoning with a partner. Partners should actively listen to each other and provide feedback, indicate agreement or disagreement, or retell the main points" (Lesson 6, page 20).

Obtaining, Evaluating, and Communicating Information

- *Communicate information ~~or design ideas and/or solutions~~ with others in oral and/or written forms using models, drawings, writing or numbers that provides detail about scientific ideas, ~~practices, and/or design ideas~~.*
    - Lesson 1: Part of this element is claimed in the lesson. Students verbally share their phenomenon storylines with a partner, and the teacher is told, "Pre-assess students' ability to communicate information from their models clearly and effectively" (Lesson 1, page 15).
    - Lesson 2: Part of this element is claimed in the lesson. Students are scaffolded to create models (artifact 2.2) and the teacher is told, "To communicate their thinking, students can draw, label their drawings, and/or provide a written explanation" (Lesson 2, page 21).
    - Lesson 3: Part of this element is claimed in the lesson. Students communicate their ideas about the investigative phenomenon orally and by using words and drawings.
    - Lesson 5: Part of this element is claimed in the lesson. In Student Artifact 5.4, students communicate scientific information about the phenomenon via drawing and writing.
    - Lesson 6: Part of this element is claimed in the lesson. In Student Artifacts 6.1 and 6.2, students communicate scientific ideas about air changing the size and shape of an object.
    - Lesson 7: Part of this element is claimed in the lesson. Students use models, drawings, writing, and numbers to complete a graphic organizer on Student Artifact 7.1 that describe scientific ideas about changing the size and shape of objects.

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 because there is a close match between the grade-appropriate DCI elements that are claimed and evidence of students using and developing those DCI elements in service of making sense of the phenomenon.

PS1.A Structure and Properties of Matter

- *Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties.*
    - Lesson 2: Part of the last sentence of this element is claimed in the lesson. Students make observations of matter at different temperatures.
    - Lesson 3: This element is claimed in the lesson. Students sort and classify different kinds of matter and conduct an investigation that results in seeing different effects of heat on different kinds of matter. For example: "Say, 'At the beginning of the lesson, we decided that we wanted to figure out if heat, or higher temperatures, affected different types of matter. How would you describe how each type of matter changed when it was heated?' As the class discusses the changes they observed, record the change next to the type of matter on the number line using words like 'liquid,' 'burned,' 'flexible solid,' and 'cooked solid,' to help students recall the change that occurred for each type of matter" (Lesson 3, page 30).
    - Lesson 4: This element is claimed except the words "and classified." In the lesson students make observations of different types of matter after heating and cooling.
    - Lesson 5: This element is claimed. In the lesson, students use observable properties to describe and classify different types of matter before and after they are heated.

  - Lesson 6: This element is claimed. In the lesson students use understanding of the effects of heating and cooling on materials and develop ideas related to observable properties, describing how different types of matter react to blowing air (Student Artifact 6.1).
  - Lesson 7: This element is claimed in the lesson. Students use this element to create their final explanations of the anchor phenomenon (Student Artifact 7.1).
- *A great variety of objects can be built up from a small set of pieces.*
  - Lesson 1: Part of this element is claimed in the lesson. Students observe a glass pitcher being made of smaller pieces and connect this observation to other similar phenomena (Lesson 1, page 12). They are therefore building toward this understanding.
  - Lesson 5: This element is claimed in the lesson. Students manipulate a model to describe that objects can be built up from a small set of pieces. For example: "During their investigation, students observed a great variety of objects made from smaller pieces. Multiple groups used the same small set of starting materials (candle wax, wax crayons), yet they were able to make a wide variety of objects. Use this discussion to support students in developing a new disciplinary core idea: a great variety of objects can be built up from a small set of pieces" (Lesson 5, page 21).
  - Lesson 7: This element is claimed in the lesson. Students are expected to explicitly use this idea in their final explanations as well as in their discussions about real world applications. For example: "Discourse: Students' responses are expected to demonstrate understanding that a great variety of glass objects can be built up from small glass pieces. Listen for students to articulate that glass objects can break into smaller pieces and that those smaller pieces can be heated, put together into larger pieces, and have their shape changed" (Lesson 7, page 21).

PS1.B Chemical Reactions

- *Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not.*
  - Lesson 1: Part of this element is claimed in the lesson. Throughout the lesson, students observe and discuss heating and cooling causing changes in glass as part of the anchor phenomenon.
  - Lesson 2: Part of this element is claimed in the lesson. Throughout the lesson, students observe and discuss heating causing or not causing changes in glass during investigations and media observations.
  - Lesson 3: Part of the first sentence of this element is claimed in the lesson. Students conduct investigations and see the effects of heating on different substances.
  - Lesson 4: This element is claimed in the lesson. In the lesson students are introduced to the idea of reversibility. For example: "The word 'reversible' should be identified and used from this point forward to describe changes to matter that can be undone or changed back by either heating or cooling" (Lesson 4, page 27).
  - Lesson 5: This element is claimed in the lesson. Students describe changes caused by heating or cooling as reversible or irreversible.
  - Lesson 6: Part of this element is claimed in the lesson. In the lesson students use ideas about reversible and not reversible changes and about the effects of heating and cooling a substance (glass). This is a background idea for this lesson, though, that focuses on changes through the force of air versus temperature changes.
  - Lesson 7: This element is claimed in the lesson. Students use this element to create their final explanation (Student Artifact 7.1).

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

The reviewers found extensive evidence that students have the opportunity to use or develop the CCCs in this unit because there is a close match between the grade-appropriate CCC elements that are claimed and evidence of students using and developing those CCC elements in service of making sense of the phenomenon.

In the beginning of Lesson 1, the teacher is told, "if you have not already done so, hang the How Are You Working Like a Scientist of Engineer Today? poster in a visible location. Throughout the unit, use this tool as a visual to draw students' attention to the practices and concepts they engage in" (Lesson 1, page 6). This indicates that the teacher may explicitly mention CCCs that students use, although this is not always done at the element level.

Patterns

- *Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.*
    - **2-PS1-1** is a Performance Expectation (PE) claimed in the unit (PDF, page 6). This PE is associated with the above CCC element. However, the unit materials do not include a claim to this CCC or element (e.g., PDF, page 7). Students have opportunities to use this element in several lessons (see below for evidence).
    - Lesson 3: "After everyone has shared, refer to the class list and ask, 'Does anyone notice any patterns related to matter melting?'" (Lesson 3, page 19).
    - Lesson 3: "Students are assessed on their ability to use the simulation to make observations (from media) to identify the patterns that result from the simulated heating events" (Lesson 3, page 27).
    - Lesson 3: "Students use evidence from the heating events to identify the observable pattern that lower temperatures do not usually cause a change in observable properties, higher temperatures can cause changes in observable properties, and higher temperatures cause many types of matter to change from solid to liquid. It is important that students understand that not every observation will fit the pattern but that most of their observations will" (Lesson 3, page 29).
    - Lesson 4: "Teacher TIP: Patterns: Remind students that patterns can be things that are repeated, such as blue, red, green, blue, red, green, but patterns can also be events that have a repeating relationship, like the seasons (summer, winter, spring, fall). To students at this age, noticing patterns is often a first step to organizing and classifying what they see. Students look for similarities and repetition, possibly even a sense of order. Learning to identify patterns will support students' growth toward making sense of phenomena and asking scientific questions about why and how a particular pattern occurs" (Lesson 4, page 30).
    - Lesson 4: "Personal Connection: Have students share a pattern they have seen or experienced in their everyday life. After they share, ask students to answer the question in Step 3 of the Looking for Patterns section of Student Artifact 4.2 by using their understanding of patterns to explain how patterns can help you make predictions" (Lesson 4, page 31).

Cause and Effect

- *Events have causes that generate observable patterns.*
    - Lesson 2: The first part of this element is claimed in the lesson. This part of the concept is explicitly supported. For example: "Every day we experience 'causes' and what

happens as a result. In science, we call this a cause-and-effect relationship. If you remember from Unit 1, a cause is why something happened, and the effect is the result of what happened. … Have students individually draw and label an example of a cause-and-effect relationship from their personal experience on the graphic organizer" (Lesson 2, page 11). Later in the lesson, explicit prompts are given to students. For example: "How can you use the words 'cause' or 'effect' to explain if a kitchen oven could be used to make new glass objects? (The kitchen oven is not hot enough to cause the pieces of glass to become more flexible, change color, and come together as one glob [effect])" (Lesson 2, page 22).

- Lesson 3: This element is claimed in the lesson. Students make observations and the teacher is told, "Explain that students will use their observations to identify what happened during the test (effect) and why it happened (cause). Be explicit that students will use the lens of cause and effect to analyze and describe their results" (Lesson 3, page 18). The teacher is given prompts to help students develop the idea of the first three words of the element. Later in the lesson the class brings in the idea of patterns. For example: "Circulate room and engage with students as they work to ensure they are using the lens of cause and effect to identify patterns as they compare the heating events from both investigations. Use the following prompts as needed: ...If you compare your observations from the simulation and from the clamp lamp investigation, what pattern(s) do you notice?" (Lesson 3, page 29). In Student Artifact 3.2, students are directed to "Using the terms 'cause' and 'effect,' write or draw two patterns you can identify from the evidence you collected."
- Lesson 4: This element is claimed in the lesson. Students are supported to explicitly think about and apply this concept, including through this teacher prompt: "Explain to students that time is an event that can affect the outcome of an investigation or phenomenon…This emphasis on time as an event to consider when analyzing data supports the crosscutting concept element that events (heating and cooling) have causes that generate observable patterns (changes over time to observable properties of matter)" (Lesson 4, page 26). The teacher is also told, "Remind students that cause-and-effect events can generate patterns that we can see. Ask, 'What patterns do you notice in the data we recorded?'" (Lesson 4, page 30). Note that the following teacher prompt may confuse teachers about which CCC they are supporting: "Explain that by finding patterns of similarities and differences, students are developing the crosscutting concept of patterns through the lens of cause and effect and that this understanding can help them recognize patterns in their everyday lives." Later in the lesson, students engage in sense-making using this element: "Students should use evidence from multiple heating and cooling events to identify these observable patterns. It is important that students understand that not every observation will fit the pattern but that most of their observations will. Students may identify some of the following patterns: Lower temperatures do not always cause a change in observable properties…" (Lesson 4, page 39).
- Lesson 5: This element is claimed in the lesson. Students explicitly describe cause and effect relationships (heating glass) generating an observable pattern of change (Student Artifact 5.2).
- Lesson 6: This element is claimed in the lesson. Students compare the observable properties and patterns of objects before and after air is blown into them. "Final Thoughts, Directions: Use words and drawings describe how blowing air into an object affects the properties, size, and shape of the object. Use observable patterns to describe cause-and-effect relationships" (Student Artifact 6.1).

- *Simple tests can be designed to gather evidence to support or refute student ideas about causes.*
    - Lesson 2: Part of this element is claimed in the lesson. Students collaboratively design simple tests of their predictions, and they are given prompts related to cause and effect including: "Remember, if our predictions were not supported by our data, that is okay. We were still able to collect data that we can use as evidence to explain how this heat source affected the marbles'" (Lesson 2, page 15). Later in the lesson: "What caused the changes to the glass? Think about our class investigations. What temperature does it need to be to see changes in the pieces of glass?" (Lesson 2, page 22). The teacher is also told, "Class Discussion: When all groups have heated and cooled their materials, recorded their observations, and identified the cause-and-effect relationships, facilitate a class discussion about the observations made and the data collected to support the element that simple tests can be designed to gather evidence to support or refute student ideas about causes" (Lesson 4, page 27).
    - Lesson 4: This element is not claimed in Lesson 4, but the lesson builds towards it. After an investigation, the teacher is told, "facilitate a class discussion about the observations made and the data collected to support the element that simple tests can be designed to gather evidence to support or refute student ideas about causes" (Lesson 4, page 27). The detailed "Discourse" notes for this section support this element implicitly (not explicitly): "Have students or groups share how they filled in their cause-and-effect relationship sentences and explain why they can make that claim by citing the evidence they gathered in their tables." By citing evidence they gathered, some students may build an underlying understanding that their investigations provide evidence to support cause-and-effect relationships, but because this is not discussed explicitly, there is no evidence that all students would make this connection or that any students would recognize this as a general concept that could be applied in the future.

Energy and Matter

- *Objects may break into smaller pieces and be put together into larger pieces or may change shapes.*
    - Lesson 1: Part of this element is claimed in the lesson. The teacher is told, "This unit may be students' first experience with this crosscutting concept. As students engage in discourse, draw their attention to the beginning scene of the anchoring phenomenon, in which the pieces of broken glass are placed in the hot oven. As students continue to identify important events in the anchoring phenomenon, make sure they are referring to each event through the lens of these broken pieces being 'put together' to make something entirely new (e.g., the pieces of broken glass melted together in the oven, the melted pieces of glass expanded like a bubble, the melted pieces were rolled in colorful sprinkles, etc.)" (Lesson 1, page 13). This experience helps students start to develop an implicit understanding of this concept. Later in the lesson, the teacher is told "Encourage students to use the lens of energy and matter and the science idea that objects can be broken apart and put together to create something new by considering ways they have built new objects from smaller pieces. Invite students to share these ideas along with other similar experiences to the events with the class and document them on the Similar Experiences chart" (Lesson 1, page 21).
    - Lesson 5: This element is claimed in the lesson. The teacher is told, "Emphasize the term 'pieces' to help surface prior knowledge of target expectations. Consistent use of the term 'pieces' supports students they develop understanding and

conceptualize matter in ways that are consistent with how matter will be described in later grades (particles, atoms, etc.)” (Lesson 5, page 9).
  - Lesson 6: This element is claimed in the lesson. Students argue that air can change the size and shape of an object (Student Artifact 6.2). Early in the lesson, students are reminded of this specific CCC element (Lesson 6, page 8).
  - Lesson 7: This element is claimed in the lesson. Students use the understanding that pieces of glass can be put together into larger objects or have their shape changed in their final explanations. “Apply Ideas: Connect to Unit 1, which focused on reducing what we throw away. Provide each pair of students with two sheets of paper, one of which is recycled. Ask if any of the ideas students developed could help them explain how paper is recycled. (It gets broken into pieces, and the pieces change shape as they are put together into new pieces of paper.)” (Lesson 7, page 17).
  - Overall, the materials do not fully or deeply address the breaking apart of a larger object to produce the small pieces that are then used to make something new. The beginning of the glassblowing phenomenon video shows larger shapes of clear glass products being smashed and combined, but educators are not currently prompted to pause and discuss with students from where the small pieces of glass originated, and what the larger glass objects’ previous purpose(s) may have been.

Suggestions for Improvement

General
The unit and lesson level front matter helpfully incorporates strikethroughs to indicate portions of elements not being addressed at certain times. However, the unit materials do not explicitly distinguish between elements that are fully used, elements that are partially used, elements that are fully developed, and elements that are partially developed. Consider adding language to explicitly address this spectrum of use and/or development.

Science and Engineering Practices

- Consider careful cross-reference of the elements claimed in the “Three-dimensional Learning” section of the Unit Overview and the elements included in the Learning Progression charts (both unit overview and lesson level) to ensure consistency of claims.
- Student expectations related to modeling and constructing explanations could be interpreted to be above grade level. Consider using the evidence statements (e.g., for **2-PS1-3**) to frame expectations for all students, and using SEP expectations from higher grades (e.g., explanatory models) as extension activities.
- Consider adding more evidence to support claim of **Developing and Using Models** element: *Distinguish between a model and the actual object, process, and/or events the model represents*. Alternately, this claim could be removed.
- Consider clarifying why the SEP element *Asking questions based on observations to find more information…* is claimed as in unit front matter, but then Lesson 1, Part D, Ask Questions About the Anchoring Phenomenon, Step #2 states that it is not assessed in the unit.

Disciplinary Core Ideas
None

Crosscutting Concepts
- Consider making student expectations explicit when students are only expected to be introduced to a concept rather than understand it fully.
- Consider taking advantage of student discussion of patterns in the unit to explicitly include the **Patterns** CCC element as a learning goal.
- Consider including explicit discussions about the CCC element *Simple tests can be designed to gather evidence to support or refute student ideas about causes.* It is currently implicit in the unit, and some students may develop this understanding simply by engaging in investigations, but other students may need explicit scaffolding to understand this as a generalizable concept.
- The "break apart" portion of the **Energy and Matter** CCC element is not currently thoroughly discussed in the unit. Consider incorporating educator direction to pause the Art of Glassblowing anchor phenomenon video before 0:05 to have students make observations of and/or ask questions about the origins of the glass pieces that are melting. This could highlight the fact that the small pieces that are being used in the glassblowing process are originally from larger glass products.

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/or designing solutions to problems because there are several performance events that provide clear evidence that the targeted grade-appropriate elements of the three dimensions are used together, and this integration facilitates sense-making. Additionally, one-dimensional learning is rare in the unit.

Three-dimensional, lesson-level PEs are provided for each lesson, and in each lesson, students are supported to engage in three-dimensional performances using elements of the appropriate grade level. For example:
- Lesson 2: *Make observations from simple tests to gather evidence to support ideas about how heat can cause the observable properties of glass to change.* Students "use their collected data as evidence to compare the effects of different temperatures (from different heat sources) on the observable properties of glass" (Lesson 2, page 18). This performance uses the following claimed three dimensions:
    - SEP: *Make observations (firsthand or from media) ~~and/or make measurements~~ to collect data that can be used to make comparisons.*
    - CCC: *Events have causes ~~that generate observable patterns~~*.
    - DCI: *~~Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.~~ Matter can be described ~~and classified~~ by its observable*

properties. Heating ~~or cooling~~ a substance may cause changes that can be observed. ~~Sometimes these changes are reversible, and sometimes they are not~~.

- Lesson 2: *Communicate the idea that heating to a high temperature caused the pieces of glass to stick together and change properties (flexibility and color).* "Student Artifact 2.2, students construct a model to communicate the idea that the high temperature of the furnace caused the pieces of glass to stick together (melt), become more flexible, and change color" (Lesson 2, page 25). This performance uses the following claimed three dimensions:
    - SEP: *Communicate information ~~or design ideas and or solutions~~ with others in oral and or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, ~~and or design ideas~~*.
    - CCC: *Events have causes ~~that generate observable patterns~~*.
    - DCI: *~~Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature.~~ Matter can be described ~~and classified~~ by its observable properties. Heating ~~or cooling~~ a substance may cause changes that can be observed. ~~Sometimes these changes are reversible, and sometimes they are not~~*.
- Lesson 3: *Use evidence from observations to construct an explanation to communicate the effect higher temperatures can have different types of matter.* "Students use models, drawing, writing, or numbers to develop an explanation for the beginning events of the anchoring phenomenon. Students explain how heat affects different types of matter by completing Student Artifact 3.3" (Lesson 3, page 40). This performance uses the following claimed three dimensions:
    - SEP: *Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.*
    - CCC: *Events have causes that generate observable patterns*.
    - DCI: *Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. Heating ~~or cooling~~ a substance may cause changes that can be observed. ~~Sometimes these changes are reversible, and sometimes they are not.~~*
- Lesson 4: *Make first-hand observations and collect and compare data around how heating and cooling matter causes patterns of reversible or irreversible change.* "The data students collect and analyze serves as evidence to support their answer to their investigative question and students begin to see that matter can change not only when it is heated but also when it is cooled and that some of those changes can be reversed. Developing this idea supports sensemaking by allowing students to: Begin to answer the question, 'Why did the artist keep putting the glass back into the furnace?'" (Lesson 4, page 34). This performance uses the following claimed three dimensions:
    - SEP: *Make observations (firsthand or from media) ~~and/or make measurements~~ to collect data that can be used to make comparisons*.
    - CCC: *Events have causes that generate observable patterns*.
    - DCI: *Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, ~~and sometimes they are not.~~*
- Additional three-dimensional learning performances in the unit include:
    - Lesson 1: *Use observations to construct and communicate an initial explanatory model for how the pieces of broken glass became a colorful pitcher.*
    - Lesson 3: *Plan and conduct an investigation to produce data on how an increase in temperature can cause the observable properties of some types of matter to change.*

- Lesson 3: *Use evidence from observations to construct an explanation to communicate that the effect higher temperatures can have different types of matter.*
- Lesson 4: *Construct an argument with evidence that heating and cooling glass causes its observable properties to change and that these changes to glass can be reversed.*
- Lesson 5: *Develop and use a model to describe how an object can break into small pieces, be heated be put together with other pieces, and change shape.*
- Lesson 5: *Construct an argument about what the colored pieces are made of using evidence that heating and cooling cause changes in the pieces and their observable properties.*
- Lesson 5: *Use evidence from observation to describe how glass can break into small pieces, be heated, and be put together to make a colorful glass pitcher.*
- Lesson 6: *Make observations and measurements to collect data that can be used to describe the effect of blowing air into flexible objects.*
- Lesson 6: *Construct an argument with evidence to support the idea that air may change the size and shape of an object.*
- Lesson 7: *Use observations and ideas developed throughout the unit to communicate a final explanation for how the pieces of broken glass became a colorful pitcher.*

Suggestions for Improvement

Suggestions for improvement in Criterion I.B related to grade-appropriateness of student performances, especially related to SEPs, would help increase the amount of time students engage in grade-appropriate, three-dimensional learning during the unit.

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 PEs because individual lessons work together by building on the previous lesson(s) and a coherent path to learning seems evident from the student perspective. Additionally, students are supported to fully build toward proficiency in the targeted PEs.

Individual lessons build directly on prior lessons and unit materials make the links between lessons explicit to the students, often engaging students in answering and adding to their questions and using evidence from investigations to add to the class explanatory model. For example:

- At the end of each lesson, student questions are returned to. For example, in Lesson 2: "Once the class has revised their initial ideas, have students identify which of their questions on the model they can now answer. After students answer a question, write a checkmark on the sticky note to symbolize that the question has been answered" (Lesson 2, page 22).
- Lesson 1 ends with the class figuring out what question they should investigate first, and Lesson 2 begins with reminding students about the anchor phenomenon and what they decided to figure out about it first (e.g., Lesson 2, page 8).
- Lesson 4: "Have students or groups share the questions they were thinking about throughout the investigation and the answers they found in the evidence they gathered from both Student Artifact 4.1 and Student Artifact 4.2" (Lesson 4, page 29).
- Lesson 5 ends with students deciding what they want to figure out next and Lesson 6 begins by revisiting this decision: "Direct students' attention to the Class Consensus Model. Help students reflect on what they figured out in the previous lesson and the question they decided to figure out next (e.g., Why did the artist blow into the pole?)" (Lesson 6, page 8).
- Lesson 6: At the end of the lesson, the teacher is told, "Help students anticipate the next lesson in the storyline. Say, 'Wow, it sounds like you really understand what the artist was doing. I think you are ready to answer the unit driving question on our Class Consensus Model (e.g., How do objects change into other objects?)'" (Lesson 6, page 21).
- Three of the lessons have class routines that require students to re-make the same decision they already made or re-ask the same question they already asked. For example:
  - Lesson 2 ends with the class figuring out what question they should investigate next (i.e., why doesn't the pole melt?), but Lesson 3 does not begin by immediately acknowledging this previous decision by returning to that question. Instead, students make new observations and are asked to repeat the conversation to come up with the same question to investigate (Lesson 3, page 12).
  - Lesson 3 ends with the class figuring out what they should investigate next: "End the discussion by saying, 'So, I hear several of you mention that the artist keeps putting the glass blob back into the furnace and then taking it out again. Who agrees that this might be a good part of the glassblowing story to investigate next?'" (Lesson 3, page 39). Lesson 4 begins with students making observations of a new investigative phenomenon that is related to topic from Lesson 3, and eventually students re-examining the anchor phenomenon to come up with something they wonder about it. Student decisions from Lesson 3 about what to investigate next are re-elicited anew: "As a class, decide what question to investigate next based on the anchoring phenomenon, the previous investigation, and previous class discussions" (Lesson 4, page 19).
  - Lesson 4: During a reflection discussion after student investigations, the teacher is given several prompts to use, including: "Do you think that all changes to matter can be reversed? Why or why not? How could we test that?" (Lesson 4, page 33). They then are told to "Display Digital Resource: Temperature Simulation. Guide the class to come to a consensus on a question to investigate using the temperature simulation" (Lesson 4, page 36) without connecting explicitly to what students discussed testing. Additional teacher notes ask students to come up with a new question to test. Therefore, this new activity may not seem to fit together coherently with the end of the previous activity.

   - Lesson 4 ends with students deciding what they want to investigate next, but Lesson 5 begins without referring to these questions and decisions. Instead, the class revisits the anchor phenomenon, and the teacher is told to say, "It sounds like you are learning a lot about this. Let's take a closer look at materials the artist started with." "Project Digital Resource: Lesson 5 Images and display the image of transparent, broken glass. Have students observe this image individually for about a minute" (Lesson 5, page 8). Previous student questions are briefly referred to afterward, but not in a way that uses them to progress the instruction: "Let's take a look at the other pieces. You asked good questions about them last time. Display the image of transparent and colored pieces. Have students observe this image individually for about a minute" (Lesson 5, page 9).

Support is provided to make connections between units of instruction, both at the beginning and the end of this unit. For example:

- Lesson 1: "Say, 'Last night, I accidentally broke a drinking glass during dinner. I carefully cleaned up my mess and was getting ready to throw the pieces of glass away, but I started thinking about Unit 1 and how we came up with different solutions for reducing what we throw away. I wondered whether there might be a way to reuse the pieces of broken glass. I even thought that I might be able to make something new out of them'" (Lesson 1, page 8).
- Lesson 7: "Connect to Unit 1, which focused on reducing what we throw away. Provide each pair of students with two sheets of paper, one of which is recycled. Ask if any of the ideas students developed could help them explain how paper is recycled. (It gets broken into pieces, and the pieces change shape as they are put together into new pieces of paper.)" (Lesson 7, page 17).

Three-dimensional, lesson-level learning performances are specified for each lesson. In addition, three full NGSS PEs are claimed as learning goals in the unit. The lessons work together to provide sufficient opportunities for students to build proficiency in all the targeted learning for all three dimensions:

- **2-PS1-1**. *Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties*.
- **2-PS1-3**. *Make observations to construct an evidence-based account for how an object made of a small set of pieces can be disassembled and made into a new object*. Note, however, that disassembly (in contrast to assembly) is only briefly the focus of a class discussion in the unit.
- **2-PS1-4**. *Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.*

Suggestions for Improvement

- In the beginning of Lessons 3, 4, and 5, consider acknowledging, connecting back to, and using students' decisions or questions from the end of the previous lesson. For example, in the beginning of Lesson 4, the teacher could say something like "Before we turn to the next step we planned in the last lesson, let's take a look at our investigations to see if anything has changed."
- Consider strengthening the class discussion of the "disassembly" part of **2-PS1-3** to ensure that students thoroughly understand and can use that concept.

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 because the unit phenomena can all be fully explained by the physical sciences domain and CCCs are used across domains several times, but only implicitly.

The identified anchoring phenomena — "the art of glassblowing" (PDF, page 4)— driving the learning can be fully addressed within the physical science domain. The materials make some implicit connections to other science disciplines using the unit driving question — "How can objects change into other objects?" (PDF, page 5) — but explicit connections are not made. Examples of informal and implicit connections between science domains in the unit include:

- When addressing **2-PS1.4**, the unit makes casual references to **2-ESS2-3**: Obtain information to identify where water is found on Earth and that it can be a solid or liquid. However, the related Earth and space core idea (**ESS2.C: The Roles of Water in Earth's Surface Processes**) is not explicitly called out in the unit, nor does it need to be to address the phenomenon.
- Lesson 4: "In prior grades, students may have been exposed to reversible and irreversible changes in their everyday lives through the study of weather. Students may have used the pattern of seasons to demonstrate understanding that a lake changes from liquid water in the summer to frozen water in the winter and back to liquid water in the summer without using scientific language" (Lesson 4, Page 6).
- Lesson 4: "Equity: Connecting instruction to phenomena in students' homes, communities, or cultures enables students to deepen their understanding and improve sensemaking. Invite students to share some analogous phenomena related to changes in matter from solid to liquid or liquid to solid. Common analogous phenomena…pond by my house freezes solid in the winter" (Lesson 4, page 14).

Grade-appropriate elements of CCCs are used in reference to more than one science domain. However, the cross disciplinary connection is not made explicit for students. In the examples below, the use of the CCC was explicit for students but the connection to the Earth or life sciences domain was only implicit:

- Lesson 4: "Assessment: Informally assess students' understanding at this point in the lesson to plan future instruction. On their artifact sheets and as they engage in the discourse as a class, look for individual students' ability to…use examples from other areas of their lives when they have observed cause and effect: leaves change color in the fall, pond freezes in the winter for skating…" (Lesson 4, page 15).

- Lesson 2: "Cause and Effect: Though students have had multiple experiences with this concept in prior units and grades, they may benefit from a review. As needed, scaffold this step by providing an initial example (e.g., The television was loud, so I turned the volume down, or It rained today and now there are puddles everywhere). As a class, identify the cause and the effect in the example statement. Draw it on the graphic organizer and label the cause and the effect to provide a visual for students" (Lesson 2, page 11).
- Lesson 2: "Cause and Effect: Provide extra support for students who struggle to identify the cause-and-effect relationship between heat and glass…Supply each student with a different image (or media clip) that displays a clear example of cause and effect. This could include things like a child falling off a bike, seeds being watered and then germinating, and a dog obeying a command…Have students discuss whether they agree or disagree with the identified cause and effect and why" (Lesson 2, page 26).
- Lesson 4: "Teacher TIP: Patterns: Remind students that patterns can be things that are repeated, such as blue, red, green, blue, red, green, but patterns can also be events that have a repeating relationship, like the seasons (summer, winter, spring, fall)" (Lesson 4, page 30).
- Lesson 4: "Why can we walk on a lake in the winter but not in the summer?...Observable features of the student performance: Student is able to use an analogous phenomenon to construct and argument with cause-and-effect relationships and patterns to explain that when lake water warms in the spring and summer, it stays liquid, but when temperatures cool in the winter, it causes the liquid lake water to become solid ice. Knowledge of seasons supports the idea that this phenomenon repeats year after year, confirming that changes to this property of water are reversible" (Lesson 4, page 52).

Suggestions for Improvement

Although not required to fully address the identified anchor phenomenon, consider making connections across disciplines, where they exist, more explicit for educators and students. This can be done for both DCI content and CCC connections.

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics, English language arts (ELA), history, social studies, or technical standards because the materials explicitly acknowledge specific mathematics and ELA standards. In addition, these standards are incorporated such that students use the mathematics and ELA skills to make sense of data and scientific concepts. However, reading opportunities for all students are only provided in one format (an article) and only optional extension activities provide opportunities for other reading formats (e.g., websites).

CCSS in mathematics and ELA are listed in the materials. For example:

- CCSS connections are listed for each lesson (PDF, pages 15–19), and detailed information about their inclusion in the lessons is provided on pages 33–35. For example:
    - **2.MD.A.1**: *Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.*
        - Lesson 6: “Students use a ruler to measure the size of a flexible object before and after air is blown into it. Students use whole numbers to record measurements to the nearest inch or centimeter” (PDF, page 33).
    - **W.2.3**: *Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts, and feelings, use temporal words to signal event order, and provide a sense of closure.*
        - “During Lessons 1, 3, 5, and 7, students develop explanatory models of the anchoring phenomenon. In these explanatory models, students use firsthand and media observations to recount a sequence of events and construct an evidence-based account. Students’ explanatory models become increasingly more detailed and utilize more complex science ideas in Lessons 3, 5, and 7” (PDF, page 34).

Students have a variety of opportunities to practice grade-appropriate mathematics skills in the unit to help understand the scientific results. For example:

- Lesson 2: Students use mathematics to analyze the results of their investigations:
    - “Math Connection: On chart paper, write different combinations of temperatures from the class tests, such as 212 and 100, for students to compare. If time permits, have students use the symbols to make comparisons individually in their science notebooks. Alternatively, make these comparisons together as a class” (Lesson 2, page 17).
    - “Help students build their understanding of both place value and temperature’s role in the changes by asking students to compare two temperatures at a time using >, =, and < symbols” (Lesson 2, page 17).
- Lesson 3: Supports are provided for students to use and develop mathematics proficiencies:
    - “Direct students’ attention to the number line you prepared. Point out the hash mark labeled ‘0.’ Ask students to skip-count aloud by 100 while you label hash marks from 100 to 1000. Explain that the class investigated temperatures even higher than 1000˚F. Model how to skip-count and label the remaining hash marks from 1000 to 2600” (Lesson 3, page 29).
    - While placing the types of matter on the number line, probe student understanding of three-digit numbers by asking questions such as, “Do you think 170 is closer to 100 or 200?” As needed, remind students which digit represents the hundreds, tens, and ones positions (Lesson 3, page 30).
- Lesson 4:
    - “Using 5-minute intervals for their observations engages students in practicing CCSS.Math.Content.2.MD.C.7: Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m.” (Lesson 4, page 22).
    - “Add the lower temperatures to the number line created in Lesson 3. Probe student understanding of two- and three-digit numbers by asking questions such as, ‘Do you think 32 is closer to 0 or 100?’ As needed, remind students which digit represents the hundreds, tens, or ones positions” (Lesson 4, page 37).
- Lesson 6: “Students have had several opportunities to record observations. In this investigation they progress to recording measurements as well. Support students in using a ruler to measure

length. Ensure that students understand the units they use for measurement (inches or centimeters) and record them on their artifact sheet" (Lesson 6, page 13).

Students have a variety of opportunities to practice their writing, speaking, and listening skills in the unit to explain and communicate their understanding of the science. However, there is only one opportunity for all students to engage in reading (either individually or through listening to the teacher read) during the unit, and that reading only includes one text modality. Related evidence includes:

- Lesson 1: "Before playing the video, have students make a T-chart in their science notebooks. On one side, have them write 'What I notice,' and on the other side, have them write 'What I wonder.'…Think-Pair-Share: Provide time for students to record their observations from the video in the 'What I notice' column of the T-chart in their science notebook. Next, have students share their observations with a partner" (Lesson 1, page 9).
- Lesson 2: "Distribute Literacy Article: Heating Up the Arts to each student. Have students read the article individually. Ask them to underline or highlight important ideas and circle words they do not know" (Lesson 2, page 20). The teacher is also told, "Identifying important ideas in informational text is a useful skill in most subject areas. Depending on the needs and abilities of your students, consider providing scaffolds. For example, some students may benefit from reading this article with a partner or in a small group. Students can work together to identify the important ideas." Note that the reading level of the fourth and fifth paragraphs of the article may be a little above Grade 2 according to several Lexile analyzers.
- Lesson 3, Part A, Initial ideas, Step #3: "Ask students to think for a couple of minutes about why the pole did not melt in the hot furnace, and then to communicate their ideas to a partner. After time to share, have students write 'Initial Ideas About the Pole' on a page in their science notebooks and then individually record their ideas about the pole" (Lesson 3, page 12).
- Students who have reached proficiency ("full understanding") or those with high interest are given several opportunities for continued research, reading, writing, listening, and speaking through the "Enrichment After Assessment" sections.

Suggestions for Improvement

- Consider incorporating a greater number and variety of formats through which students can engage with reading skills. For example, infographics, websites, and a variety of grade-appropriate books could be added to the unit to help strengthen students' understanding of the science as well as their literary skills.
- Currently, CCSS connections are listed only at the beginning of the unit (although they are labeled by individual lessons). It could be helpful for teachers if they were also listed in each lesson where they are used together with the elements of the three dimensions used in that lesson.

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 because the way the anchor phenomenon is presented has the potential to inspire some curiosity among most students and the materials contain multiple opportunities for students to make connections to personal experiences.

The phenomenon is contextualized as being relevant to students, and they experience it through a video:

- Unit Overview, Teacher Background, Anchoring Phenomenon: "The phenomenon of glassblowing, although a specialty that students may not have witnessed firsthand, is relevant to students because of its ability to recycle and reuse pieces of ordinary glass to make something new, beautiful, and useful" (page 4).
- Lesson 1: "Say, 'Last night, I accidentally broke a drinking glass during dinner. I carefully cleaned up my mess and was getting ready to throw the pieces of glass away, but I started thinking about Unit 1 and how we came up with different solutions for reducing what we throw away. I wondered whether there might be a way to reuse the pieces of broken glass. I even thought that I might be able to make something new out of them.' Ask, 'How do you think I could reuse the pieces of broken glass? I will give you a couple of minutes to think about this before we discuss everyone's ideas.' Have students to spend a minute or two brainstorming ways to reuse the glass pieces and then discuss their ideas with a partner. Once students feel comfortable with their ideas, facilitate a class discussion. As students share, record their ideas on the Ways to Reuse Glass chart" (Lesson 1, page 8). Students then watch a video that shows the anchor phenomenon: "pieces of broken glass are heated and shaped into a colorful pitcher" (Lesson 1, page 9).
    - Note that no other evidence indicates that students would be facilitated into believing that figuring out the glassblowing anchor phenomenon itself (rather than individual parts of the phenomenon that are indeed connected to students' lives) would be important to them or to someone they can relate to, as few students are likely to have had personal experience with glassblowing. However, that lack of prior personal experience is likely to result in increased student curiosity about the anchor

phenomenon. Students would be motivated to figure out what is going on because they don't already know.
    - Throughout the unit, with the extensive use of personal connection prompts, educators are guided to connect the figuring out of the phenomenon to other aspects of students' experiences. In addition, artistic students are likely to be excited about the anchor and investigative phenomena in the unit, as it provides them with a new art form (glass) to think about.
- Lesson 1: Students can directly handle glass, giving them a more personal connection to the anchor phenomenon: "Pass some of the glass marbles around the room for students to touch and observe closely. Explain that the marbles are made of glass, like the broken pieces they saw in the anchoring phenomenon" (Lesson 1, page 13).
- Lesson 2: Students conduct investigations to observe an investigative phenomenon. Most observations are direct but one (requiring oven heating) is done via video (e.g., Lesson 2, page 15).

Unit materials provide extensive guidance for how to connect lessons to common and/or personal experiences from the individual student perspective. For example:

- Lesson 1: The teacher is told, "Encourage students to make a meaningful connection to the anchoring phenomenon by asking the following questions: Where have you seen something like this before? Does something you saw in the anchoring phenomenon remind you of anything you've experienced in your life? Record the connections students share on the 'Connections to the Anchor' chart" (Lesson 1, page 12). Example analogous phenomena are given.
- Lesson 1: The teacher is told, "Have students identify analogous phenomena from their homes, neighborhoods, communities, or cultures that relate to the events from the anchoring phenomenon. … Invite students to share these ideas along with other similar experiences to the events with the class and document them on the Similar Experiences chart." Example analogous phenomena are given (Lesson 1, page 21).
- Lesson 2: Students watch a video clip, and the teacher is told, "Have students share any prior knowledge or personal experiences they have with what they saw in this video clip by asking: Have you ever seen broken glass? Where was it? How did it happen? Have you ever seen glass put into an oven? Where were you? What did the glass look like?" (Lesson 2, page 8). The teacher is prompted to "Ensure that each student is involved in the discussion. Students may feel comfortable using a 'thumbs up/thumbs down' response to some questions. Make sure that all students have the opportunity to elaborate on their experiences as they feel comfortable."
- Lesson 3: "Every student has different experiences, and they should be encouraged to share those experiences with the class. Similar experiences, often referred to as analogous phenomena, help students activate prior knowledge, which will help them make stronger connections throughout this lesson. Examples of analogous phenomena include: Using a stick to roast marshmallows or hotdogs in a campfire…" (Lesson 3, page 11).
- Lesson 3: "Have students reflect on the personal connection they made to melting earlier in the lesson (e.g., ice cream, ice cubes, snow, cheese). Have students identify if their experience resulted in a change like the changes in the types of matter they have been investigating. In most instances, students' experiences will result in the matter changing from solid to liquid because of a heat source. Ask, "How do our personal experiences fit into the patterns we have identified during our investigations?" (Lesson 3, page 31).
- Lesson 4: "While they wait between observations or for their turn to heat their materials, have students share personal experiences about waiting for something to heat up with the class. Have them identify the cause and the effect in their experience. After one person shares, allow a

few other members of the class to provide feedback on the identified relationship" (Lesson 4, page 23).
- Lesson 5: "Have students make a connection to the images by identifying analogous phenomena they have experienced in their everyday lives. Ask, 'Where have you seen something like this before? What does this remind you of?' If students' connections generate new questions, use sticky notes to add them to the Class Consensus Model" (Lesson 5, page 9).
- Lesson 6, Part A, Initial Ideas, Step #4: "Personal Connection: Ask students to share prior, related experiences from their everyday lives. After ample time for students to share, say, 'Wow, it sounds like this happens a lot'" (Lesson 6, page 9).
- Lesson 7: At the end of the unit, students consider what unanswered questions they still have. The teacher is told, "Encourage and support students in seeking answers to their questions. Facilitate sharing of students' findings with the class, family members, or community members. If answering a question requires an investigation(s) that students can conduct safely, consider hosting or participating in a science fair" (Lesson 7, page 10).

Educators are supported to cultivate student questions that come from their experience, community, or culture.
- Lesson 1: "Asking Questions: During this unit, the ability to ask questions based on observations is not assessed. However, the opportunity for students to ask questions now and in future lessons will be instrumental in driving student learning throughout the unit. Students' questions should be related to their own interests in and personal experiences with the anchoring phenomenon or analogous phenomena. Have students reference their own personal experiences, the Class Consensus Model, Student Artifact 1.1, the Notice and Wonder Chart, and the Similar Experiences chart for inspiration" (Lesson 1, page 23).
- Lesson 7: "Say, 'It sounds like you are saying that the pieces of broken glass changed into a colorful pitcher. Do you think other objects can change into new things?' Have students discuss their ideas with a partner, and then facilitate a class discussion…. Students are expected to connect ideas they have developed during the unit to objects and experiences from their homes, neighborhoods, communities, or cultures. Listen for examples that apply the same crosscutting concept (Objects may break into smaller pieces and be put together into larger pieces or change shape) to a new context (e.g., construction toys, paper-mâché, mosaic art, indigenous pottery)" (Lesson 7, page 15).
- Lesson 7: Prompt students to think of personal experiences or questions they have that can be explained and answered using ideas and concepts from this unit (Lesson 7, page 17).

Suggestions for Improvement

The unit currently includes extensive connections between parts of the anchor phenomenon and students' lives. Consider providing additional suggestions for educators about how they can communicate to students the importance of figuring out the *full glassblowing phenomenon itself*. This could be done by problematizing the phenomenon, such as adding more emphasis on the need to reuse pieces. For example, the video could be paused to talk about reasons why we would want to reuse pieces — which problems that would solve. Alternately, students' perception of the relevance of the anchor phenomenon itself might be increased by allowing students opportunities to interact with a local glassblowing artist. A local artisan could be found as an alternative to the suggested STARworks website for students outside North Carolina.

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 because student ideas are frequently elicited throughout the unit and students have multiple opportunities to give, receive, and reflect on peer feedback to revise their thinking.

The unit materials provide a significant number and variety of opportunities for students to express, clarify, justify, interpret, and represent their ideas so that the culmination of artifacts show and represent a change in student thinking over time. For example:

- Lesson 1: "Discourse: Before eliciting student ideas, it may be helpful to review the established discussion norms for your classroom. If the class does not have an established list of discussion norms, facilitate a discussion for students to agree on discussion rules. It is recommended that the class list include at least three norms: one regarding respect, one regarding equity, and one regarding accountability" (Lesson 1, page 8).
- Lesson 1: There are supports for sharing ideas from all students: "Have all students share an idea with the class to ensure that all voices are heard, honored, and valued. If time permits, invite each student to share an observation and a question. If time is short, have one person from each pair share an observation they discussed with their partner and the other share a question they discussed" (Lesson 1, page 10).
- Lesson 1: The teacher is given sample prompts to help draw out student ideas, including "Why do you think these are important events?" (Lesson 1, page 13).
- Lesson 1: The class creates a consensus model using student ideas of the ordering of major events in the anchor phenomenon (Lesson 1, page 19). During the discussion, the teacher is given prompts to elicit deeper student thinking, e.g., "Does anyone disagree with making [event] one of our main events? Why?"
- Lesson 2: "When it is their turn to listen, have students engage in social awareness by using the 'Someone Else's Shoes' SEL [Social Emotional Learning] strategy to adopt a new perspective from which to listen, examine, and connect to the information their partner provides. As students engage in the SEL strategy to promote social awareness, encourage them to listen to their partner's experiences, ask questions, and make a connection to the experience as best as they can" (Lesson 2, page 23).
- Lessons 3 and 4: Discussion tables are provided to give suggested discussion prompts and follow ups to sample student responses to drive deeper thinking (Lesson 3, pages 21, 31, and 37; Lesson 4, pages 18, 32, and 41).
- Lesson 3: "Have students discuss with a partner what type of matter the artist's pole from the anchoring phenomenon must be made of and what evidence they have to support their claim. Circulate the room and engage with pairs as they discuss their claims and how to support them" (Lesson 3, page 35). Follow up student prompts are provided.

- Lesson 5: "Initial Ideas: Ask, 'What do you notice about the colored pieces? What do you wonder about them?' Facilitate a class discussion for everyone to share what they noticed and wondered. Next, use talk moves to ask probing questions and press for explanations" (Lesson 5, page 9).
- Lesson 6: "During the class discussion, encourage students to use their preferred means of expression and communication to describe evidence that blowing air into a flexible material can change its shape" (Lesson 6, page 13).
- Lesson 7: "Have students reflect on how their ideas and understanding have changed since the beginning of the unit. Students should be provided time to think individually first, then share in pairs, and then share with the class" (Lesson 7, page 16). Suggested talk moves and prompts are provided.

The unit materials provide extensive opportunities for students to give, receive, and respond to peer feedback about their thinking. For example:

- Lesson 1: Students share their question lists with a partner and the pairs "discuss each other's questions and work together to modify or add additional questions about the anchoring phenomenon to their lists" (Lesson 1, page 24).
- Lesson 2: "Have students share their cause-and-effect relationship with a partner. After each person shares, the other person should provide feedback on the identified relationship" (Lesson 2, page 12). The following suggested feedback prompts are provided: "I agree that this is the cause/effect because ____. I disagree that this is the cause/effect because ______."
- Lesson 2: "Have students present and explain their models to a partner. Afterward, have each student share peer feedback by comparing their model to their partner's. As needed, provide a little time for students to make changes to their models based on the peer feedback they receive" (Lesson 2, page 21). Guidance for the feedback content and format is provided.
- Lesson 3: "When everyone has finished, encourage students share their explanations with a partner. Each member of the pair should give and receive peer feedback. Have the partner who is listening use the Gotta Have Checklist to orally describe what they agree with and suggest how their partner could strengthen their explanatory model" (Lesson 3, page 38).
- Lesson 4: "To help students stay on track, consider having students work in groups. Each group should choose one person to be the Speaker. All others in the group will provide feedback. Prompt the Speaker to share their cause-and-effect example with the group, explaining which part is the cause and which is the effect. The others in the group should each provide feedback on the relationship. As needed, provide sentence starters like the following: I agree this is the cause/effect because _____. I disagree that this is the cause/effect because ______" (Lesson 4, page 23).
- Lesson 4: When students give their poster presentations, the teacher is told, "Have the rest of the class provide feedback to the presenters using these sentence starters: We saw evidence of this, too, when we ______. Our evidence is different, so maybe _______" (Lesson 4, page 40).
- Lesson 5: "Invite students to share their claim, evidence, and reasoning with a partner. Students should actively listen to one another other and provide feedback by responding to the questions in the Feedback section of their partner's artifact sheet. Allow students the opportunity to revise their claim, evidence, or reasoning on Student Artifact 5.3 after receiving peer feedback. Remind them to make changes to the graphic organizer in a different color" (Lesson 5, page 18).
- Lesson 5: "Have students share their explanatory model with a partner. Encourage peers to use the Gotta Have Checklist as they respond to Step 1 of the Feedback section of their partner's artifact sheet" (Lesson 5, page 23).

- Lesson 6: "Invite students to share their claim, evidence, and reasoning with a partner. Partners should actively listen to each other and provide feedback, indicate agreement or disagreement, or retell the main points…When students have finished, have students turn to the Peer Feedback section of Student Artifact 6.2 and ask their partner for feedback. Allow students the opportunity to revise their claim, evidence, or reasoning after receiving feedback from their partner" (Lesson 6, page 20).

The unit materials provide multiple opportunities for students to receive and respond to teacher feedback. For example:

- Lesson 4: "Have students share with their group members which types of matter they circled and placed an X near and the evidence from their investigations that supports their claim that changes to those types of matter can be undone or not undone. As they share, ask students to give one another feedback using the following sentence frames: I agree with you, but _______? What do you mean by _____? Could you tell me more about _____?" (Lesson 4, page 38). At the same time, the teacher is told, "Provide feedback to groups as you listen to students give peer feedback. Rephrase any misconceptions using sentence frames that are similar to the student's original sentence to model appropriate and helpful feedback."
- Lesson 4: The teacher is told, "Circulate the room as pairs develop claims. Provide feedback such as: Do you both agree with that claim? Is that claim an answer to your question?" (Lesson 4, page 46). This is not necessarily an example of feedback so this instruction may be confusing to teachers.
- Lesson 4: "Explain that each pair of students will come to come to the front of the room and use Student Artifact 4.4 to present the evidence-based argument they constructed. As each pair presents, the other students in the class should listen carefully and use the feedback prompts on the chart and feedback sheet to provide feedback on the argument for three pairs of students" (Lesson 4, page 48). The teacher is also told, "Provide positive feedback to each partner group. After every pair has shared and received peer feedback, provide time for students to individually review the feedback their pair received and revise their claim, evidence, and reasoning if they would like. Encourage students to make changes to Student Artifact 4.4 in a different color." Note that the feedback teachers are intended to give here is not clear and may not support student thinking.
- Lesson 5: "Review the plan for the model each group developed and provide verbal feedback on its strengths and weaknesses. After discussing each group's model with them, allow time for students to make changes to their model based on your feedback" (Lesson 5, page 11). However, the teacher is also told, "do not directly state what is incorrect or unsafe about their model. Consider using the following prompts to help you engage with groups and provide verbal feedback: Why did you select ______ to represent ________? What could you do to make small colored pieces?..." which may seem contradictory and confusing.
- Lesson 5: "Collect Student Artifact 5.3 and use it to formatively assess student learning. Provide each student with written feedback on their argument by completing the final step of the artifact sheet when you review it" (Lesson 5, page 18).
- Lesson 5: "Provide each student with written feedback on their artifact sheet by completing the final step of the artifact sheet when you review it. Ensure that all students have opportunities to receive written peer and teacher feedback" (Lesson 5, page 24).

Suggestions for Improvement

Consider ensuring that teachers are supported with examples of what good feedback looks and sounds like that would be helpful to support changes in 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	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials identify and build on students' prior learning in all three dimensions because information about intended learning progressions are provided for all targeted elements of the three dimensions. In addition, support is provided for recognizing and addressing students' prior conceptions.

Lesson materials contain a clear structure for identifying prior student learning expected for all three dimensions and outlining how the prior knowledge will be built upon. For example:

- The teacher's guide describes activities from the previous unit and proficiencies students should have previously developed (PDF, page 4). For example, it says that students:
  - "Planned and conducted an investigation to describe and classify objects in a lunchbox using their observable properties. (building toward 2-PS1-1)" and
  - "Began developing Energy and Matter concept: Objects can break into smaller pieces, be put together into larger pieces, or change shapes."
- Progressions charts are provided for each targeted element of all three dimensions (PDF, pages 20–27). The charts outline the target K–2-level element, an explanation of the element in "early grades and prior units," a brief description of how the element is addressed in Lessons 1–7, and the related element at the 3–5 grade band. For example, for an **Obtaining, Evaluating, and Communicating Information** element (PDF, pages 22–23), the chart lists:
  - "K–2 Element: *Communicate information or design ideas and/or solutions with others in oral and/or written forms using models, drawings, writing, or numbers that provide detail about scientific ideas, practices, and or design ideas."*
  - "Early Grades and Prior Units: Prior to this unit, small groups collaboratively used oral and written methods to communicate solutions to the class about how humans can reduce their impact on the local environment. During Unit 1, small groups communicated solutions to the class about ways we can reduce what we throw away."

  - "Lesson 1: Students individually communicate information in oral and written forms using models, drawings, and writing to explain in detail how the pieces of broken glass in the anchoring phenomenon became a colorful pitcher."
  - "Lesson 2: Students individually communicate information with others in oral and written forms by developing and using models, drawings, writing, and possibly numbers that provide detail about scientific ideas related to high temperatures and changes to the observable properties of glass."
  - "Lesson 3: Students individually communicate information in written form using models, drawings, writing, or numbers that provides detail about the scientific ideas related to the beginning events from the anchoring phenomenon."
  - "Lesson 4: Students individually communicate information with others in oral and written forms by using models, drawings, writing, and numbers that provide details about scientific ideas related to the effects of high and low temperatures on the observable properties of glass and reversible and irreversible changes."
  - "3–5 Element: *Communicate scientific and/or technical information orally and/or in written formats including various forms of media and may include tables, diagrams, and charts."*
- The beginning of each lesson includes detailed descriptions of how learning in each targeted element is built toward in that lesson. For example:
  - **Developing and Using Models**: *Develop and/or use a model to represent ~~amounts,~~ relationships, ~~relative scales (bigger, smaller), and/ or patterns~~ in the ~~natural and~~ designed world(s).*
    - Lesson 1: "In Unit 1, groups collaboratively developed and used models to represent patterns in and relationships between humans and the natural world. [In this lesson,] Students are provided sentence stems and guidance from their teacher to help them individually create a model on Student Artifact 1.1 that describes their initial ideas about how pieces of glass can be changed into something new. Students use the model to share their ideas with a partner" (Lesson 1, page 3).
- Lesson 2: The lesson refers to and builds explicitly on students' prior DCI knowledge: "Review the different observable properties of matter by having students use terms from the word wall that they identified during Unit 1" (Lesson 2, page 11).
- Lesson 3: "Have students use their knowledge from Unit 1 to identify the different types of matter they need to investigate" (Lesson 3, page 14).
- Lesson 4: Part of the learning progressions table discusses related student learning outside of school: "In prior grades, students may have been exposed to reversible and irreversible changes in their everyday lives through the study of weather. Students may have used the pattern of seasons to demonstrate understanding that a lake changes from liquid water in the summer to frozen water in the winter and back to liquid water in the summer without using scientific language" (Lesson 4, page 6).
- Lesson 4: When arguments are introduced for the first time in the unit, a connection is not made back to student's prior learning about arguments in kindergarten (e.g., for **K-ESS2-2**).

There is frequent support for understanding and addressing misconceptions. For example:
- Possible student misconceptions are listed at the beginning of each lesson.
- In Lesson 1, the teacher is told, "listen for these ideas as students engage in productive discourse or demonstrate learning in student artifacts. Consider discussing these preconceptions and misconceptions as they arise to see if members of the learning community have opposing

ideas. Such ideas may be identified as something that the class needs to figure out by the end of the lesson or unit" (Lesson 1, page 5). Later in the lesson, the teacher is directed to listen for these misconceptions: "As you listen to students and review their artifact sheets, note preconceptions or misconceptions so they can be revisited and addressed later in the unit" (Lesson 1, page 15).

- Lesson 3: "A common misconception to listen for as groups discuss their observations is that solids are matter but liquids are not. Although this misconception was addressed during Unit 1, it may be necessary to guide students to understand that solids and liquids are both types of matter and that they have different observable properties" (Lesson 3, page 17).
- Lesson 4: "Provide feedback and address any misconceptions about patterns that are shared by revoicing. For example, say, 'I heard you say there is a pattern on your backpack. Is that just because it is blue and white, or is that because it has blue and white polka dots that repeat themselves?'" (Lesson 4, page 41).
- Lesson 5: "Students should reach consensus that air is a type of matter that we breathe and that air is neither solid nor liquid. This description helps avoid creating misconceptions that could linger with students for many years, including: Air is not matter and does not take up space" (Lesson 5, page 10).
- Lesson 7: "Throughout the unit, students have observed that heated glass exhibits very different properties than cool glass and that the artist can use tools to change the shape of heated glass. As needed, use discourse to discuss misconceptions, such as: Materials can only exhibit properties of one state of matter" (Lesson 7, page 7).

Suggestions for Improvement
None

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 almost all scientific ideas in the unit are accurate and the teacher is supported to accept student's incomplete or inaccurate scientific ideas early on in learning.

Related evidence includes:

- Lesson 1: The teacher is reminded to accept students' incomplete or inaccurate scientific ideas at this early stage of learning. For example: "It is expected that this consensus model may exclude key events, include inaccurate science ideas, and contain misconceptions. As the class revisits this explanatory model throughout the unit, they will revise, modify, and add to it to display how their thinking is changing" (Lesson 1, page 20).

- Lesson 5: In the lesson students are supported to choose materials to make physical models of the anchor phenomenon. However, this is labeled as **Planning and Carrying Out Investigations** (Lesson 5, page 12) and when students manipulate their models the activity is referred to as an "investigation" (Lesson 5, page 13). Making and manipulating a model is not an investigation and naming it as such could lead to student misconceptions.

Suggestions for Improvement

Consider changing how the modeling activity in Lesson 5 is labeled.

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	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide guidance for teachers to support differentiated instruction because there are multiple and varied individualized strategies provided for educators to support all students where they are in their current understanding of the targeted three dimensions, helping them build toward most of the critical learning goals in the unit.

Throughout the unit, supports are provided for emerging multilingual learners. For example:

- Emerging multilingual learners (EMLs) are supported through the natural development of scientific vocabulary. For example, "A word is earned on the Word Wall when the class demonstrates a strong understanding of that key term. Until a word is earned, encourage students to use everyday language in discourse and work products" (Lesson 1, page 5).
- Lesson 1: EMLs are supported by starting discussions with everyday language rather than scientific terms: "Facilitate a class discussion to leverage students' everyday language and create a list of terms to describe the things and events they observed during the anchoring phenomenon" (Lesson 1, page 11).
- Lesson 4: "Support students who do not use the term 'cooled' to explain the investigative phenomenon… Have students make connections to their everyday lives by using a graphic organizer to sort photographs of things that are hot (warm to the touch) and things that are cold

(cool to the touch). Students should practice using the words 'hot,' 'warm,' and 'cool' to describe the sorted objects" (Lesson 4, page 25).

Throughout the unit, supports are provided for all students to engage in multiple modalities, and the materials indicate that these supports are helpful for emerging multilingual learners, students who struggle with written communication, and students with disabilities. For example:

- Lesson 1: "Allow students to record their questions using multiple modalities, such as writing and/or drawing. Consider allowing students who struggle with writing to use technology to voice-record their questions. Alternatively, these students could share their questions orally with a peer, who can then record the student's questions exactly as they stated them" (Lesson 1, page 23).
- Lesson 2: "Provide extra support for students who struggle to demonstrate their understanding using written language. This strategy supports English language learners, students who struggle with written communication, and students with special needs. Provide opportunities for students to demonstrate understanding using drawings, gestures, or oral language" (Lesson 2, page 19).
- Lesson 4: "Assist students who struggle to communicate a cause-and-effect event and the patterns related to the cause of the event by providing a sentence prompt such as the following to help them structure their thoughts: 'The _________ caused the plastic object and the _________ and the _________ to _________.' In addition, some students may benefit from communicating the cause-and-effect relationships they have identified using oral language and gestures" (Lesson 4, page 39).
- Lesson 5: "Provide extra support for students who struggle with documenting observations. Encourage students to use alternatives to written language. They can describe what they saw (observations) using pictures, verbally, kinesthetically, or in a way that supports their own expressive communication proficiency (e.g., augmented communicative device, sign language). Patterns can be expressed by using regular, predictable, repetitive expressions to describe a recurring event…. Provide students with dough or clay and ask them to use it to form new objects. Have students describe how the matter changes while they are working. Students should communicate the understanding that matter can break apart, come together, and change shape to form a variety of new objects from the same starting material. Encourage students to use their preferred mode of communication (written, oral, pictorial, or kinesthetic)" (Lesson 5, page 15).

Throughout the unit, supports are provided for students who struggle. For example:

- Lesson 1: The teacher is provided with strategies to support students who struggle with the performance in Student Artifact 1.1 (Lesson 1, page 17). These strategies aid with student sense-making and with SEP-related performances (modeling), but not with the CCC.
- Lesson 2: Suggestions are provided for students who struggle with part of a CCC: "Students will use this crosscutting concept as a focal lens throughout this unit. Though students have had multiple experiences with this concept in prior units and grades, they may benefit from a review. As needed, scaffold this step by providing an initial example (e.g., The television was loud, so I turned the volume down, or It rained today and now there are puddles everywhere). As a class, identify the cause and the effect in the example statement. Draw it on the graphic organizer and label the cause and the effect to provide a visual for students" (Lesson 2, page 11).
- Lesson 3: Supports are provided for students struggling with the DCI. For example: "Revisit students' experiences with melting. Common experiences include ice cubes, ice cream,

popsicles, and snow. Encourage students to list all the melting experiences they can think of on a piece of chart paper" (Lesson 3, page 25).

- Lesson 3: "Provide extra support for students who struggle to make comparisons to explain the effects of higher temperatures on different types of matter. Project Digital Resource: Temperature Simulation for the group and explore plastic together, clicking one temperature at a time and discussing how the matter changed or did not change compared to the temperature it was before (e.g., Plastic: 68˚F: no change, 158˚F: no change, 212˚F: no change, 338˚F changed from solid to liquid)" (Lesson 3, page 33).
- Lesson 4: "If students are struggling to identify patterns in the class data, help them find evidence in their data that shows that sometimes matter (like wax and butter) changed from a solid to a liquid when the temperature increased, but then it went back to being a solid when the temperature decreased. Write S, L, S on the board as an example pattern" (Lesson 4, page 30).
- Lesson 4: "Provide extra support for all students who struggle with understanding how patterns can be used as evidence to describe our phenomenon" (Lesson 4, page 45). Note that teachers and students were not told they should be using the CCC related to patterns being used in this way, so the supports described here may be confusing.
- Lesson 5: "Provide extra support for students that do not understand that the colored pieces are made of glass or that pieces got picked up by the heated glob of hot glass" (Lesson 5, page 20). Remediation activity steps are listed.
- Lesson 6: "Provide extra support for students who struggle with making or recording measurements…Provide students with common classroom objects. Have students practice selecting and using appropriate tools such as rulers, yardsticks, metersticks, and measuring tapes, and then using the selected tool to measure the length of the objects. Have students practice recording their measurements using both numbers and appropriate units" (Lesson 6, page 16).

Throughout the unit, extensions are provided for students with high interest. For example:

- After each lesson's formative assessment opportunity, the teacher is provided with an extension activity to support students who already have a full understanding or high interest.
- Lesson 1: Students can compare and contrast a similar glassmaking process (Lesson 1, page 18). Deeper understanding in SEP performance is unlikely to be supported in this activity.
- Lesson 2: Students can read about a related phenomenon and make posters, communicating the similarities and differences between the two phenomena. Deeper understanding in CCC performance is unlikely to be supported in this activity.
- Lesson 3: Students can research lava and share their research with the class (Lesson 3, page 26).
- Lesson 4: "Have students set up a recording device to capture the process of matter in their home or community changing from a solid to a liquid or from a liquid to a solid. Have students create a presentation for the class that explains the process they recorded. Students' presentations should use key vocabulary words (heating, cooling, solid, liquid, liquefy, etc.)" (Lesson 4, page 35).
- Lesson 4: "Individually or in small groups, challenge students to develop a number line of negative temperatures. Students should conduct research to identify instances of negative temperatures in the real world. The number line should include both the temperature and a visual representation of the material object. As an added challenge, require students to cite their sources of information" (Lesson 4, page 45).
- Lesson 6: The extension provided on page 17 mirrors one already provided in Lesson 3 (lava).

- Lesson 7: The teacher is given the following directions: "Throughout the unit, students have collaboratively planned and carried out investigations to produce data and gather evidence to answer questions. During Extension activities, students built on these experiences and progressed to obtaining information independently using various text, text features, or media to answer questions" (Lesson 7, page 9).

Suggestions for Improvement

Consider providing an alternative or modified version of the literacy article "Heating Up the Arts" for students who read below grade-level.

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 strategies and guidance are provided to guide the educator in linking student engagement across lessons, as well as for linking learning in all three dimensions to students' sense-making.

Frequent guidance is provided for educators to support linking student engagement across lessons. For example:

- A unit storyline and unit pacing guide are provided for teachers (PDF, pages 8–11). This includes for each lesson:
    - A column labeled "What is figured out that helps students explain the anchoring phenomenon and answer the lesson question?" For example, in Lesson 4: "Why does the artist keep putting the glass in the furnace? The artist keeps putting the partly shaped glass 'glob' back into the furnace before it is finished being shaped so that the glass stays flexible and easy to shape. If the glass cools too much, the artist will not be able to shape it, and it might break. If the glass is heated too much, the glass might melt too much and fall off the pole. This heating and cooling and reheating demonstrates a reversible change" (PDF, page 9).
    - A column labeled "Unit Coherence." For example, in Lesson 4: "Why does the artist keep putting the glass in the furnace? Students expand on the idea of heating causing

changes to matter by exploring the effects of cooling and reheating on types of matter. Students figure out that when the glass is removed from the furnace, it cools, and that it must be reheated in order to keep its flexibility. Students develop the idea that this is an example of a reversible change" (PDF, page 11).

- At the beginning of each lesson, the teacher is given a description of how this lesson fits in the overall unit storyline (e.g., Lesson 2, page 2).
- Frequent facilitation notes are found in every lesson for connecting lessons to each other and to the anchor phenomenon, and for helping students monitor their progress toward explaining the anchor phenomenon. For example, in Lesson 2: "As needed, remind students that the Class Consensus Model helps them remember the parts of the glassblowing process. Because that process is like a story, the class decided at the end of Lesson 1 to investigate the beginning events first (placing broken glass into the hot oven)" (Lesson 2, page 8).

Learning in the unit is explicitly linked to sense-making in classroom discussions, and there are many explicit discussions to help students see how their learning of some of the elements in all three dimensions helps them explain the phenomenon. For example:

- Lesson 3, Part D, Advance Sense-making of the Anchor, Step #4, Teacher Guidance: "Constructing Explanations: A Gotta Have Checklist helps students support one another as they figure out what concepts or ideas are needed to make sense of the beginning stages of the glassblowing phenomenon. Students' explanations of these ideas on Student Artifact 3.3 will likely include illustrations, labels, and sentence fragments. The explanatory model students create on this artifact sheet will help students progress toward a stronger explanation of the anchor later in the unit" (Lesson 3, page 37).
- Lesson 4: As students analyze data from an investigation related to their sense-making, the teacher is told, "Explain that by finding patterns of similarities and differences, students are developing the crosscutting concept of patterns through the lens of cause and effect and that this understanding can help them recognize patterns in their everyday lives….Remind students that cause-and-effect events can generate patterns that we can see. Ask, 'What patterns do you notice in the data we recorded?'" (Lesson 4, page 30).

Suggestions for Improvement

None

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time. Educators are provided with prompts that help to guide when, where, and how to adjust scaffolds related to the targeted SEP elements. However, although scoring guidance is provided related to student use of SEPs (see Criterion III.C) and supports are provided for students struggling with SEPs (see Criterion II.E), little guidance is provided to identify the needs and current proficiency of individual students as they progress toward independence in targeted SEP elements.

The progressions charts on pages 20–27 describe some changes in scaffolding over time for some targeted elements. This was seen for the targeted elements of **Constructing Explanations**, **Engaging in Argument**, **Communicating Information**, and **Energy and Matter**, for one of the targeted elements of **Planning Investigations** (*Plan and conduct an investigation collaboratively….*), for one of the targeted elements of **Cause and Effect** (*Events have causes…*), and for all the DCIs. These are also present at the beginning of each lesson (e.g., Lesson 2, pages 3–4). For example:

- **Constructing Explanations:** *Use information from observations (firsthand and from media) to construct an evidence-based account for natural phenomena.*
    - Lesson 3: *"*Students individually use evidence collected from their observations of first-hand tests and the simulation to construct (with provided sentence starters) an evidence-based account that describes the beginning events from the anchoring phenomenon."
    - Lesson 7: *"*Students individually use evidence collected from firsthand investigations and media to construct (without sentence starters) an evidence-based account that describes the ending events of the anchoring phenomenon. Students progress in this element by combining three evidence-based accounts to construct a complete explanatory model of the anchoring phenomenon."

  There is a difference in student expectations and supports between these three lessons. Early in the unit students are supported with sentence starters to write their explanations, whereas by the end of the unit, students are expected to individually write these explanations without sentence starters.
- **Cause and Effect:** *Events have causes that generate observable patterns.*
    - "Prior to this unit, students should have become familiar with the general idea of cause-and-effect relationships through their previous exploration of the effect of sunlight on Earth's surface, how to prepare for and respond to severe weather, and the impacts humans have on the local environment. Though students should be able to identify these relationships, it is not expected that they fully understand the concept that these events generate observable patterns."
    - Lesson 3: "Students work with their group to analyze the data collected to use as evidence to support the concept that heating events have causes that can generate observable patterns."
    - Lesson 5: "Students build on prior understanding of cause-and-effect relationships by using patterns to describe changes in heated glass."

After every formal assessment opportunity, the teacher is given suggestions for "Remediation After Assessment," some of which focus on supporting student understanding of SEP elements. For example, in Lesson 4: "Provide extra support for students who struggle to construct an argument using evidence to support a claim. This strategy supports English language learners, students from diverse backgrounds, economically disadvantaged students, and students with special needs. Create sentence frames with word banks and pictures so that students can create a rebus that includes evidence from their observations to support their claim. Assist students with limited language proficiency (receptive or expressive) to find innovative ways to communicate his/her ideas" (Lesson 4, page 51). However, when these supports are provided related to SEP elements, they are only provided one time for each element and the scoring guidance is not often detailed enough to provide guidance for the teacher to understand which individual students might need these supports, other than students who fall into the named groups above (see evidence in Criterion III.C).

Not all the rows of the progressions charts show true progressions. Instead, they show descriptions of student use of elements with the same amount of scaffolding over time. For example:

- **Developing Models:** *Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).*
    - "Prior to this unit, students used a model to represent the relationship between the needs of different plants and animals (including humans) and the places they live. Students also developed and used simple models to represent relationships, relative scales, and patterns to make their thinking visible at key points in different units."
    - Lesson 5: "Students progress in this element by developing a physical model in small groups and using it to represent relationships and relative scales (bigger, smaller) related to processes in the designed world of glassblowing." This does not describe a progression of the element — only an application in a different context.

In the lessons themselves, students generally received fewer scaffolds over time for several of the targeted SEP elements, although some scaffolding reappears later after being reduced earlier. For example:

Developing and Using Models

- Lesson 1: "Explain that students will make a model that tells the story of how the pitcher was made from many pieces of broken glass. To do this, they need to arrange the images in the order in which they observed them in the anchoring phenomenon… As students construct their models, encourage them to include labels for the images, additional drawings, symbols, and even written phrases or sentences that help explain their thinking. Have them use a question mark to represent anything they are unsure of" (Lesson 1, page 14).
- Later in the unit, students do not receive these instructions from the teacher about what to include in models — they are expected to include them on their own or through comparing to the "Gotta have it checklist."
- Lesson 3, Part C, Investigation, Step #3, Teacher Guidance: "Developing and Using Models: This may be the first time that students have used a simulation (model) to gather evidence to help them identify patterns in the natural and designed worlds. The use of this practice is not assessed during this lesson. Instead, students are assessed on their ability to use the simulation to make observations (from media) to identify the patterns that result from the simulated heating events" (Lesson 3, page 27). Note that using a simulation to gather evidence goes beyond the K–2 expectations of all students. The teacher is told to say, "Scientists use models like this simulation to represent processes and objects that are too difficult to study first-hand (e.g., too small, too unsafe, too far away). This simulation will help us safely observe what happens to objects that are placed in the artist's furnace" (Lesson 3, page 27). Note that this same teacher statement is repeated in Lesson 4 (Lesson 4, page 36) without stating to students that it is a reminder (so it may sound repetitive).

Planning and Carrying Out Investigations

- Lesson 2, Part B, Investigate, Step #7, Teacher Guidance: "Planning and Carrying Out Investigations: Students will not be assessed on planning skills in this lesson. Instead, the planning process is scaffolded as a whole-class opportunity to help prepare students for Lesson

3, in which they will work in small groups to plan and conduct an investigation" (Lesson 2, page 13).

- Lesson 3, Part B, Investigation, Step #2, Teacher Guidance: "Planning and Carrying Our Investigations: During this lesson, groups progress to planning their own investigation with minimal assistance from the teacher. Student Artifact 3.1 provides sentence starters and prompts to help scaffold and focus students' attention on key aspects of an investigation. During future lessons, students will receive fewer scaffolds during the planning stage" (Lesson 3, page 15).
- Lesson 4: Students work in small groups to plan an investigation with use of an investigation planning sheet (Student Artifact 4.2). "Students should work together to list ideas for how they can test both high and low temperatures using the materials from their previous investigations…Listen for students to describe what to test and how to test the effects of heating and cooling on different types of matter. If students don't discuss this, help them consider why it is important to gather evidence for different types of matter rather than just one type" (Lesson 4, pages 19–20). "As you look over each group's investigation plan, provide verbal feedback on strengths and weaknesses of the plan" (Lesson 4, page 21).
- Lesson 6: Students plan an investigation without the aid of an investigation planning sheet (Lesson 6, page 12). However, the class plans the investigation collaboratively, so there is more scaffolding for student investigations than in Lesson 4.

Engaging in Argument from Evidence

- Lesson 4: "Tell the class that they will use something called a CER graphic organizer. Explain that CER stands for 'claims, evidence, and reasoning' and that this graphic organizer will help them see if they have figured out why the artist keeps putting the unfinished glass back into the furnace" (Lesson 4, page 46). A sidebar note to the teacher says, "Student Artifact 4.4 includes sentence starters and prompts to help students create an evidence-based claim. Student Artifacts 5.3 and 6.2 are also a CER graphic organizer, but those sheets each provide fewer supports than the previous, guiding students to more independently constructing their evidence-based arguments." The teacher also models an example claim and reasoning (Lesson 4, page 47) for the students.
- Lesson 5: "In this lesson, teacher modeling has been removed, but sentence starters continue to support students in constructing an argument with evidence to support a claim" (Lesson 5, page 17).
- Lesson 6: "To support students in developing claims and engaging in argument from evidence, provide sentence starters or sentence frames" (Lesson 6, page 20).

Constructing Explanations

- Lesson 3: Students are given sentence starters on their worksheet to help scaffold their early explanations, e.g., "As the glass was heated, I observed ___. I think this happened because__" (Student Artifact 3.3).
- Lesson 4: Students are given a CER chart to scaffold a full explanation, including sentence starters (Student Artifact 4.4). This increases the depth to which students are expected to use this SEP element as compared to Lesson 3.
- Lesson 5: Students are asked to individually fill out an explanations worksheet with similar sentence starters as used in Lesson 3 (Student Artifact 5.4). No change is expected in student use of this SEP element as compared to Lesson 3.
- Lesson 7: "Previous artifacts provided sentence starters and encouraged students to add labels and/or text to clarify their ideas and explanations. Scaffolds have been removed from Student

Artifact 7.1, and students are expected to provide labels and/or text without teacher input" (Lesson 7, page 12).

Suggestions for Improvement

- This criterion does not require that students progress in all elements that are used in the unit. It would be helpful to explicitly distinguish between elements that are developed and those that are only used. For example, the progressions charts could explicitly state which elements are only practiced.
- Applying suggestions for improvement related to scoring guidance (see Criterion III.C) would help ensure that teachers have the support they need to identify struggling students and monitor their progress along a progression toward proficiency and independent use of SEPs.
- Consider ensuring that scaffolding is not reintroduced after being removed without noting to the teacher why it is being reintroduced.

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena and/or design solutions. The unit incorporates frequent three-dimensional student performance tasks throughout the unit materials in which students produce artifacts that reflect use of SEP, DCI, and CCC elements for sense-making. However, major assessment opportunities have significant mismatches between assessment targets and evidence of what students are asked to produce.

The materials provide frequent opportunities for students to produce direct, observable artifacts of three-dimensional learning. Examples of three-dimensional student artifacts produced include:

- Lesson 3: “Student Artifact 3.2: *How Do Higher Temperatures Affect Different Types of Matter?* Observable features of the student performance: On their artifact sheet, students record their observations while engaging with the simulation. This observational evidence includes temperature data and any change to the observable properties of each type of matter. Students use their data to describe the cause-and-effect relationship between higher temperatures and changes to the observable properties of different types of matter. Students compare the effects of different heating events (the clamp lamp investigation and the simulation) to identify the pattern that higher temperatures cause most types of matter to change and that most commonly observed change to matter is that it changes from a solid to a liquid (Lesson 3, page 32). In this performance, students use the following claimed elements:
    - SEP: *Make observations (firsthand or from media) ~~and/or make measurements~~ to collect data that can be used to make comparisons.*
    - CCC: *Events have causes that generate observable patterns.*
    - DCI: *Different kinds of matter exist and many of them can be either solid or liquid, depending on temperature. Matter can be described and classified by its observable properties. Heating ~~or cooling~~ a substance may cause changes that can be observed. ~~Sometimes these changes are reversible and sometimes they are not~~.*
- Lesson 6: “Student Artifact 6.2: *Why Did the Artist Blow into the Pole?* Observable features of the student performance: Students use a graphic organizer to construct an argument on Student Artifact 6.2. Students apply understanding of matter to support the idea that the artist blew air into the pole to change the size and shape of flexible, heated glass. Revisions made after receiving peer feedback may appear in a separate color. Constructing an argument with evidence from unit investigations supports sensemaking by allowing students to fully answer the question, ‘Why did the artist blow into the pole?’ and build toward their explanation for how objects can change into other objects” (Lesson 6, page 22). In this performance, students use the following claimed elements:
    - SEP: *Construct an argument with evidence to support a claim.*

- CCC: *Objects may break into smaller pieces and be put together into larger pieces or change shape.*
- DCI: *Different kinds of matter exist and many of them can be either solid or liquid, ~~depending on temperature~~. Matter can be described ~~and classified~~ by its observable properties. Heating ~~or cooling~~ a substance may cause changes that can be observed. ~~Sometimes these changes are reversible and sometimes they are not~~.*

A chart describing evidence of student performance for each targeted element is found in the unit is included in the teacher guide (PDF, pages 27–31). However, not all the listed student artifacts would give evidence of student proficiency of the targeted element, including for the major assessments in the unit. For example:

- **"Cause and Effect**: *Simple tests can be designed to gather evidence to support or refute student ideas about causes*. In Lessons 2 and 4, students use simple tests to carry out an investigation that they plan in small groups. They use the observations they record during the investigations to help them support their ideas about causes. In addition to conducting simple tests and recording observational data during the investigations, students also record patterns or connections between this investigation and other investigations from the unit. On Student Artifacts 1.1, 2.1, 2.2, 4.1, 4.2, and 4.3, students document how the observable properties of different types of matter change as temperatures increase. Students collect data from their investigations and identify the pattern that heating events cause many types of matter change from solid to liquid" (PDF, page 32). In this example, the stated student artifacts show evidence of grade-appropriate use of SEPs and DCIs but will not necessarily show any evidence that students understand the concept that *simple tests can be designed to gather evidence to support or refute student ideas*. Merely conducting simple tests and using observations to support their ideas does not indicate that students know why they were conducting the tests or why they were able to support their ideas.
- Many of the major assessments ask students to use an SEP element from the middle school level. For example, students return to their explanations several times in the unit (e.g., Lessons 5 and 7), but the SEP part of the student performance rubric for this performance goes beyond the K–2 grade level. The targeted SEP is **Constructing Explanations**, but full understanding is described as "Student's explanatory model accurately communicates all the ideas from the Gotta Have Checklist the class developed" (Lesson 5, page 25; Lesson 7, page 13), which describes a middle school level performance: *Construct an explanation using models or representations.* Student artifacts would therefore be grade inappropriate.

A transfer task with a rich scenario is described as a possible formal summative assessment. However, the task was not included in the unit and therefore was not reviewed.

Suggestions for Improvement

Consider revising the assessment prompts and guidance to ensure that students are not asked to produce artifacts significantly above their grade-appropriate level.

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

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because each lesson includes at least one formal formative assessment opportunity that connects to all three dimensions, and students engage with each formative assessment organically throughout the lesson, performing a variety of tasks. Frequent support is provided for modifying instruction based on certain types of student misunderstandings in at least one of the three dimensions, although this support is not often provided for all three dimensions over a range of performance. Formative assessment guidance also does not always match the stated assessment targets.

Opportunities are called out for formal formative assessment consistently throughout materials, and those opportunities are paired with guidance for instructional decision-making. For example:

- Each lesson has at least one formal formative assessment opportunity. Each time, teachers are told to "Collect Student Artifact [1.1] and use it to formatively assess student learning. Refer to the following table for assessment and scoring guidance that will help you interpret students' performance as related to the three dimensions" (e.g., Lesson 1, page 15). In the side bar on the same page, the teacher is also told, "Use formative assessment to inform future instruction and to support students in meeting the targeted expectations."
- For the formal formative assessment opportunity in each lesson, there is a detailed assessment guidance table with assessment targets, observable features of the student performance, and scoring guidance (e.g., Lesson 1, page 16).
- After the formal formative assessment opportunity in each lesson, the Options for Supporting All Learners section provides support to educators for Differentiation During Assessment, Remediation After Assessment, and Enrichment After Assessment. This support serves as guidance for next steps based on the identified formative assessment artifact. For example, this support is described in Lesson 2, pages 19–20.

Some of the scoring guidance in the formative assessment tables does not fully match the stated assessment targets or would be difficult for teachers to interpret. For example:

- Lesson 1: The student performance rubric may be somewhat difficult for teachers to interpret (see evidence in Criterion III.C). Ideas for how to adjust instruction for students who struggle with sense-making and SEPs are included, although strategies related to CCC understanding are not included (Lesson 1, page 17).
- Lesson 2: The CCC part of the student performance rubric (Lesson 2, page 18) is unlikely to give direct evidence of student understanding of the two targeted CCC elements (see evidence in Criterion III.C), meaning that teachers won't have information to support student formative assessment of these elements.

- Lesson 3: The CCC part of the student performance rubric (Lesson 3, page 40) is unlikely to give direct evidence of student understanding of the two targeted CCC elements (see evidence in Criterion III.C), meaning that teachers won't have information to support student formative assessment of these elements.
- Lessons 5 and 7: The SEP part of the student performance rubric goes beyond the K–2 grade level. The targeted SEP is **Constructing Explanations**, but full understanding is described as "Student's explanatory model accurately communicates all the ideas from the Gotta Have Checklist the class developed" (Lesson 5, page 25; Lesson 7, page 13), which describes a middle school-level performance: *Construct an explanation using models or representations.* Teachers therefore have grade-inappropriate support to look for evidence of student proficiency.
- See Criterion III.C for additional evidence.

Opportunities are frequently available for informal formative assessment during lessons, and the unit includes frequent guidance on ways to support students who struggle with one or more of the three dimensions, including by adding to or changing instruction. For example:

- The materials contain "Discussion Tables" that provide suggested prompts, sample student responses, and possible follow-up. The "possible follow-up" column includes suggested verbal responses from the teacher, rather than instructional next steps dependent on understanding of misconceptions communicated through student responses.
- In each lesson in the formative assessment (e.g., Student Artifact 1.1), the teacher is told, "Allow students to use multiple modalities such as writing, drawing, gestures/movements, and oral language to express their understanding of the task at hand" (e.g., Lesson 1, page 17).
- Lesson 1, Part B, Initial Ideas, Step #7: "Circulate and listen to the initial ideas being shared, noting any misconceptions that may need to be revisited in future lessons" (Lesson 1, page 15).
- Lesson 3: "Provide extra support for students who struggle to identify temperature's role in changing the observable properties of matter" (Lesson 3, page 41). A suggested remediation activity sequence is described for the teacher.
- Lesson 4: "Before moving on, evaluate students to see if anyone is struggling to understand observations and data. If so, support those students using the following strategies: Provide extra support for students to communicate in multimodal ways what they observed about how observable properties changed or did not change during the investigation….Have students represent their observations using verbal explanations, drawings, actions, photographs, or video in order to increase the number of descriptive words they use to describe if and how observable properties changed when a material was removed from the heat source (cooled)" (Lesson 4, page 15).
- Lesson 4: "If students struggle with the crosscutting concepts of patterns and cause and effect, offer them analogous scenarios and sentence starters that follow the 'If, Then' pattern…Make a T-chart of things found in the freezer and things found in the fridge. Have students identify patterns among these things, for example, that freezer items are hard, are really cold to touch, and may develop ice or frost on them, and that refrigerator items are softer, not as cold to touch, and sometimes liquid. Use this strategy to reinforce the key terms related to observable properties" (Lesson 4, page 35).

Suggestions for Improvement

- Consider ensuring that the "Options for Supporting All Students" consistently align to all three dimensions. For example, the guidance could give suggestions related to all three dimensions for each formal formative assessment opportunity.

- In Lesson 3, consider providing the “Characteristics of a strong plan” (Lesson 3, page 15) to the students directly so they can monitor their own learning. Currently, these characteristics are only provided to the teacher.

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	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because all major assessment opportunities include three-dimensional scoring guidance for educators. However, some of the scoring guidance does not match the stated learning goals or may be difficult for teachers to interpret.

In each lesson’s formal formative assessment opportunity, assessment targets and scoring guidance are provided for all three dimensions (e.g., Lesson 1, page 16). This kind of guidance is also provided for the “Possible Summative Assessment” (Lesson 4, page 52). Teachers can use this formal scoring guidance as well as prompts and checklists within the materials to provide feedback to students. For example:

- Unit Overview, Assessments: “Teacher Feedback: In Lessons 2, 3, 4, 5, 6, and 7, teachers use discourse, **rubrics**, active listening, and authentic observations to provide positive and actionable feedback to students so that they can make connections, strengthen relationships, and deepen understanding of focus dimensions and their elements” (PDF, page 28).
- Lesson 5, Part A, Initial Ideas, Step #8: “Teacher Feedback: Review the plan for the model each group developed and provide verbal feedback on its strengths and weaknesses. After discussing each group’s model with them, allow time for students to make changes to their model based on your feedback. Characteristics of a strong model: Wax and crayons will be broken into small pieces. Wax or a specific color of crayon was selected to represent the transparent glass. Crayons of several colors were selected to represent the colored pieces. The colored pieces will be heated in an aluminum dish. The group recognized that using the clamp lamp will take longer than using hot water. Group’s plan describes how the clamp lamp or hot water will be used safely” (Lesson 5, page 11).

Some of the opportunities or artifacts called out as assessment are paired with a rubric or checklist for student use. While aligned with the expectations of each instructional task, the student tools are not consistently aligned with targeted three-dimensional learning goals. For example:

- Unit Overview, Assessments: “Self-Assessment: In Lessons 3, 5, and 7, students are given opportunities to self-assess their own explanatory models using the class-generated Gotta Have It checklist” (PDF, page 28). The checklists act as an outline for PEs within the context of three individual tasks, but do not necessarily function to provide guidance for students to interpret their own progress in relation to the targeted elements of the three dimensions.

- Lesson 3: Students participate in creating part of scoring guidance: "Have the class collaboratively develop a Gotta Have Checklist. This list should include everything students think is important enough to include in their new explanatory model. Record this list on the Gotta Have chart you prepared" (Lesson 3, page 37). Possible "gotta haves" are provided to the teacher.
- Lesson 5, Part D, Advance Sense-making of the Anchor, Step #3: "Say, 'It sounds like you understand a lot more about glassmaking. I think you might be ready to add to your explanation of how the artist made the colorful pitcher.' Display the 'Gotta Have' chart you prepared, and ask students what ideas they think a good explanation must include. Use students' language to list four or five statements related to the ideas developed during Lessons 4 and 5" (Lesson 5, page 22).

Some of the scoring guidance does not match the stated learning goals or may be difficult for teachers to interpret. For example:

- Lesson 1:
  - The difference between "3-Full Understanding" and "2-Partial Understanding" for CCCs is simply that "Student fully describes initial ideas…" vs. "Student partially describes initial ideas… ." It isn't clear whether students would get the same score for a full description of a partially-understood idea and a partial description of a fully-understood idea.
  - The SEP scoring guidance: "Student uses observations to construct an explanatory model of the anchoring phenomenon…" does not provide much specific detail to teachers about what to look for — this same wording could be used in a high school-level performance.
  - As a minor note, there seems to be a typo — the scoring guidance on Lesson 1, page 16 refers to student artifact 2.1.
- Lesson 2: The CCC part of the student performance rubric (Lesson 2, page 18) is unlikely to give direct evidence of student understanding of the two targeted CCC elements. For example, if students struggle to make initial predictions, it is likely that they are struggling with the SEP element *Make predictions based on prior experiences* rather than the CCC elements. In addition, the described student performance at the "full understanding" level would not show evidence that students understood the generalizable concept that *Simple tests can be designed to gather evidence to support or refute student ideas about causes.*
- Lesson 3: The CCC part of the student performance rubric (Lesson 3, page 40) is unlikely to give direct evidence of student understanding of the full targeted CCC element because it doesn't include any explicit performance where students recognize patterns: "Student's explanatory model includes drawings and accurately uses cause-and-effect statements or labels and any other labels that enhance their explanation of the anchoring phenomenon."
- Lesson 4: The CCC part of the student performance rubric (Lesson 4, page 43) is unlikely to give evidence of partial or limited CCC understanding. The "partial understanding" description says, "Student accurately describes most of the patterns of cause-and-effect relationships" and the "limited understanding" description says, "Student accurately describes two or fewer patterns of cause-and-effect relationships…." This indicates that reduced CCC understanding would only be measured by limited DCI understanding (fewer specific relationships noticed) rather than general and cross-disciplinary understanding about the relationship between causes and patterns.

- Lesson 5: The SEP part of the student performance rubric does not match the description in the "Observable features of student performance" (Lesson 5, page 14). In the former, students are asked to use a K–2-level performance: "Student develops and uses a model to represent amounts, relationships, and relative scale in the processes that the artist used to make the colored pieces change." In the latter, students are asked to use a 3–5-level performance: "Students collaboratively develop and use a model to represent the objects and processes the artist used to make the glass pitcher…. Students describe how matter changes during each step of the process and identify what the artist did that caused the colored pieces to change." No guidance is given in student prompts for students to represent amounts, relationships, and relative scales (the K–2-level performance).

Suggestions for Improvement

- In formative assessment and scoring guidance tables, the "Observable features of the student performance" are often much more detailed and aligned to the expected performance than are the "Scoring Guidance" rubric descriptions. Consider rewriting the rubric descriptions using wording from the "Observable features" column.
- Assessment and scoring guidance are provided but could be interpreted differently by different people. Example student artifacts (e.g., models, arguments) would help clarify the intended level of performance for each dimension. In addition, consider providing a range of sample student responses, not limited to just exemplar samples or responses.
- A cumulative "Gotta Have" checklist intended for student use is created through Lessons 3, 5, and 7, and a student CER rubric is provided for Lesson 4. Consider including explicit guidance for students to interpret their own progress in relation to both the instructional materials as well as the targeted three dimensions at the element level in Lessons 1, 2, and 6. Consider adjusting the educator guidance for the "Gotta Have" checklist creation to include targets related to targeted three dimensions in student-friendly language.
- Lesson 4, Part E, Advance Sense-making of the Anchor, Step #5: Students are given the CER rubric to guide notetaking and feedback when listening to the presentations of others. Consider presenting the rubric before the assignment is completed — during Step #1 — so students are aware of expectations.

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 because the unit offers opportunities that measure student learning in a variety of ways, alternate or multiple modalities are regularly encouraged and supported for students who struggle, and all students have at least two opportunities for choice of multiple modalities for their assessment responses.

Assessments in the unit are generally accessible and grade appropriate. However, some assessments have confusing, mismatched, or grade-inappropriate scoring guidance. For example:

- Throughout the unit students are shown the digital resource "The Art of Glassblowing" video as a support to set context for an activity that most students may be unfamiliar with. The materials do not assume that students are aware of glassblowing as an art form.
- Vocabulary (science and non-science) and text volume in student assessments are grade-level appropriate. Artifacts identified as assessment opportunities have text directions that communicate the expectations for student performance, and the teacher is also given oral directions to convey to students.
- The one article provided for all students to read (Lesson 2, page 20) is mostly grade appropriate but has parts (fourth paragraph about welding and fifth paragraph about the Gateway Arch) with reading levels slightly above grade level.
- Lesson 1: As part of a pre-assessment, the teacher is told to tell students: "Explain that students will make a model that tells the story of how the pitcher was made from many pieces of broken glass" and teachers are separately told, "Students will not be assessed on their ability to develop and use models during this lesson" (Lesson 1, page 14). On the corresponding student page, the instructions say, "Arrange the images you were given in the space below to **tell the story** [emphasis added] of the anchoring phenomenon. Add labels, drawings, or symbols to help explain what is happening." Instructions and assessment guidance may therefore be confusing for teachers and students because student directions do not match teacher directions.

Students are provided frequent opportunities to communicate through a choice of multiple modalities. For example:

- In each lesson in the formative assessment (e.g., Student Artifact 1.1), the teacher is told, "Allow students to use multiple modalities such as writing, drawing, gestures/movements, and oral language to express their understanding of the task at hand" (e.g., Lesson 1, page 17).
- Lesson 1: In the pre-assessment, the teacher is told, "Although writing, drawing, and labeling are expected at this grade level, consider allowing students who struggle with writing to construct their explanations orally and/or with gestures" (Lesson 1, page 14).
- Student Artifact 3.3: "How Can Objects Change into Other Objects? (Part 1) Explanatory Model. Directions: In the space below, draw, write, or use numbers to record your observations and explain what you saw" (PDF, page 145).
- Lesson 7: "Allow students with limited written language skills to respond using oral language. If other students struggle to write explanations, you may differentiate Student Artifact 7.1 by providing sentence starters such as: I observed ______. I think this happened because ______." (Lesson 7, page 11).

Student funds of knowledge are called upon throughout the unit to support sense-making through prompts to make personal connections. For example:

- Lesson 2, Part D, Advance Sense-making of the Anchor, Step #5: "Personal Connection: Have students further engage in sensemaking by asking them to identify and describe personal experiences that can explain the idea that higher temperatures can cause changes to an observable property in some type of matter. Provide time for students to think about experiences relevant to them" (Lesson 2, page 23).

- Lesson 3, Part A, Initial Ideas, Step #2, Teacher Guidance: "Equity: Every student has different experiences, and they should be encouraged to share those experiences with the class. Similar experiences, often referred to as analogous phenomena, help students activate prior knowledge, which will help them make stronger connections throughout this lesson" (Lesson 3, page 11).
- Lesson 4: "Prompt students to think about the similarities and differences they see across the data. Ask: 'How are plastic and wood similar? How are wax and metal different?' Ask, 'How do our personal experiences fit into the patterns we have identified during our investigations?'" (Lesson 4, page 30).

Suggestions for Improvement

- Consider clarifying the assessment guidance to ensure that student directions match teacher directions. For example, the guidance given to students in the Lesson 1 pre-assessment could be adjusted, e.g., changing "Explain that students will make a model that tells the story of how the pitcher was made from many pieces of broken glass" to "Explain that students will tell the story of how the pitcher was made from many pieces of broken glass." This would help match what the teacher is told to assess.
- To ensure that students get assessment directions in at least two modalities (e.g., oral and written), consider explicitly directing teachers to give students directions verbally and not just hand out student worksheets.

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 extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. Multiple forms of assessment opportunities are used in a variety of ways over the course of the materials to measure the degree to which students have accomplished the targeted three-dimensional learning. However, an explicit summative assessment is not included in the materials, and assessment guidance in the unit does not always accurately describe what is being assessed.

A chart describing where different types of assessment are embedded and where evidence for each targeted element is found in the unit is included in the teacher guide (PDF, pages 27–31). However, not all the listed student artifacts would give evidence of student proficiency of the targeted element. Related evidence includes:

- **Constructing Explanations**: "In Lessons 1, 3, 5, and 7, students use evidence collected from their observations to construct an evidence-based account for the events that led to the artist creating a colorful pitcher. Student explanatory models on Student Artifact 1.1 includes pictures, labels, words, and some sentences. As students progress through the unit, their explanatory models on Student Artifacts 3.4, 5.4, and 7.1 include more detail and use observations as evidence to explain events in the anchoring phenomenon" (PDF, page 29).

- **PS1.A**: **"**Where to Find Evidence in the Assessment: In Lessons 2, 3, and 4, students make observations through investigation that heating and cooling can cause some types of matter to be either solid or liquid. In Lessons 5 and 6, students use models to investigate and observe processes that cause the observable properties of matter to change. Evidence of Student Use of Each Element: On Student Artifacts 2.1, 3.1, 3.2, 4.1, and 4.2, students heat and cool different types of matter and record their observations of the objects' observable properties, including whether each is solid or liquid using the terms 'solid' and 'liquid.' On Student Artifacts 5.1 and 6.1, students record observations of an object's observable properties, including whether it is a solid or a liquid, before and after processes that change it" (PDF, page 30).
- **Cause and Effect**: *Simple tests can be designed to gather evidence to support or refute student ideas about causes. "*In Lessons 2 and 4, students use simple tests to carry out an investigation that they plan in small groups. They use the observations they record during the investigations to help them support their ideas about causes. In addition to conducting simple tests and recording observational data during the investigations, students also record patterns or connections between this investigation and other investigations from the unit. On Student Artifacts 1.1, 2.1, 2.2, 4.1, 4.2, and 4.3, students document how the observable properties of different types of matter change as temperatures increase. Students collect data from their investigations and identify the pattern that heating events cause many types of matter change from solid to liquid" (page 32). In this example, the stated student artifacts will not necessarily show any evidence that students understand the concept that simple tests can be designed to gather evidence to support or refute student ideas. Merely conducting simple tests and using observations to support their ideas does not indicate that students know why they were conducting the tests or why they were able to support their ideas.

All four of the assessment types mentioned in the criterion — pre-, formative, summative, and self- — are mentioned in the unit materials. Evidence related to formative assessment is described in Criterion III.B. Evidence related to the other three types is listed below:

Pre-Assessment

- Lesson 1: **"**This productive discourse is meant to reveal prior learning, spark engagement, and provide a lead-in to the anchoring phenomenon. Having students make connections to Unit 1 will help you pre-assess their retention of science ideas and practices and concepts regarding observable properties of different types of matter, their uses, and the goal of reducing waste…Sample Talk-Moves for Pre-Assessment: What ideas do you have about how I could reuse the pieces of broken glass? How does your idea relate back to what we learned in Unit 1?" (Lesson 1, page 8).
- Lesson 1: Parts of all three dimensions are available for pre-assessment: "Assessing individual observations can make visible a student's thinking across the three dimensions and help identify possible preconceptions, misconceptions, and gaps in their understanding. Pre-assess each student's ability to make observations from media and explain those observations. Can students arrange their observations in chronological order? Do students use any science ideas developed in Unit 1 to describe their observations? Do students mention the observable properties or changes to the observable properties of any type of matter they observe? Do students mention the reuse of pieces of broken glass? In addition, look for students to use the lens of energy and

matter as they identify and explain how the pieces of broken glass can be put together to make something new (a pitcher)" (Lesson 1, page 14).
- Lesson 1: The teacher is told, **"**Pre-assess students' ability to communicate information from their models clearly and effectively" related to the SEP **Obtaining, Evaluating, and Communicating Information** (Lesson 1, page 15).

Self-Assessment
- Lesson 3: "Have the class collaboratively develop a Gotta Have Checklist. This list should include everything students think is important enough to include in their new explanatory model. Record this list on the Gotta Have chart you prepared. When the class has created the Gotta Have Checklist, distribute students' completed copies of Student Artifact 1.1, on which they developed an initial explanatory model for the anchoring phenomenon. Prompt students to review Student Artifact 1.1 and notice how their thinking about the beginning stages of the glassblowing process has changed since Lesson 1" (Lesson 3, page 37). "After giving and receiving peer feedback, ask each student to complete the self-assessment portion of the artifact sheet individually" (Lesson 3, page 38). Student Artifact 3.3 includes the following questions: "Did you include all the 'Gotta Have' features in your work? Why or why not?" and "Overall, how do you feel about your explanation? Circle one with smiling, neutral, and frowning faces."
- Lesson 4: "Support students whose observations differ from the class consensus observations by prompting those students to think about how and why the observations differ. Assist students with uncovering the reasons this might have happened. Common reasons for differing observations include: writing or drawing an observation incorrectly…." (Lesson 4, page 12).
- Lesson 5: "When they finish their models, have students use the Gotta Have Checklist to evaluate their work and complete the Self-Assessment section of the artifact sheet" (Lesson 5, page 23).
- Lesson 7: "When students are finished, have them use the Gotta Have Checklist to evaluate their work by responding individually to the Self-Assessment section of the artifact sheet" (Lesson 7, page 12).

Summative Assessment
- Lesson 4: Scoring guidance is given for a possible summative assessment (Lesson 4, page 52), but the assessment itself is not included in the materials and therefore could not be reviewed. It also appears to be optional and falls in Lesson 4 of 7, so would not allow students to demonstrate their learning from the full unit.
- Lesson 7: The last student explanations in the unit could be used as summative assessment, as they are no longer used for providing feedback. However, this is labeled as formative, and not all the SEP and CCC learning goals for the unit are assessed.

Suggestions for Improvement
- To increase the rating for this criterion to Extensive, consider including an explicit summative assessment. This could be done by adding in the "possible summative assessment" mentioned in Lesson 4, or by changing the label on the Table 7.1 assessment from "Formative" to "Summative," as this assessment can already be used as a summative measure of student performance in some of the unit learning goals (although not all the SEP and CCC learning goals).
- Consider ensuring a close match between stated assessment goals and assessment guidance.

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 because the unit includes multiple, linked student performances that provide students with several opportunities to demonstrate progression of sense-making. Additionally, students utilize multi-modal feedback over the course of the unit to demonstrate new thinking based on peer and educator feedback.

Targeted learning is included in more than one activity and there are multiple assessments where students have iterative opportunities to develop and improve their performance over time. For example, students can create their final explanation (Lesson 7, page 15) after they have received and incorporated several rounds of feedback from both peers and the teacher. Lesson 7, Part C, Final Ideas, Step #1: "Return Student Artifacts 1.1, 3.3, 5.4, and 7.1 to students. Explain that students should set their initial explanatory model aside (Student Artifact 1.1) and use the others to construct a final explanatory model." In the final explanation, students use elements from all three dimensions: "Students' final explanations [SEP] should also show understanding that some changes caused by heating are reversible, but others are not [DCI]. Comparing models is also expected to show progression in students' understanding of the idea that objects can not only break into smaller pieces, they can also be put together into larger pieces and they can change shape" [CCC] (Lesson 7, page 15). Each of these three dimensions was a previous target of assessment and feedback (although not necessarily in this same combination of three dimensions). For instance, the CCC element was previously assessed in Lesson 5 (e.g., Lesson 5, page 25) and Lesson 6 (e.g., Lesson 6, page 22).

Direction is provided over the course of the materials for facilitating peer feedback, including feedback related to student performance of the targeted three-dimensional learning goals. For example:

- Lesson 2, Part D, Advance Sense-making of Anchor, Step #3: "Turn and Talk: Have students present and explain their models to a partner. Afterward, have each student share peer feedback by comparing their model to their partner's" (Lesson 2, page 21).
- Lesson 4, Student Artifact 4.4, Student Feedback Sheet: Claims, Evidence, and Reasoning Rubric: "Listen to the partners engage in argument. Check off what you hear and provide feedback using the prompts. Did the partners make a claim? (Yes/No) Did the partners use evidence to support their claim? (Yes/No) Did the partners use scientific reasons to connect their evidence to their claim? (Yes/No)" (PDF, page 212).
- Lesson 7: "Next, have students share their explanatory model with a partner and give and provide peer feedback. Encourage peers to use the Gotta Have Checklist to make suggestions and ensure that all students have opportunities to receive written peer feedback. If students wish to make additional changes, they should use different color" (Lesson 7, page 12). The teacher is also told, "Discussing each student's artifact sheet with them, and use questions to

determine if they have included all the features from the Gotta Have Checklist, and then compose written feedback. Revising explanations isn't an expectation until middle school, but allow students to incorporate feedback if they choose."

Teachers are regularly prompted to provide students with feedback — both verbal and written — related to performance in the targeted three-dimensional elements. For example:

- Lesson 3: The teacher is told, "Review each group's investigation plan and provide verbal feedback on its strengths and weaknesses. Next, allow time for groups to make changes to their plan based on your feedback" (Lesson 3, page 15). "As you look over each group's investigation plan, do not directly state what is incorrect or unsafe about their plan. Use the list of characteristics to assess each group's plan and use the pressing talk moves to engage with and provide feedback to each group." "Characteristics of a strong plan" are given to the teacher.
- Lesson 4: The teacher is told, "As you look over each group's investigation plan, provide verbal feedback on strengths and weaknesses of the plan. Do not directly state what is incorrect or unsafe with their plan. Instead, provide prompts or questions for groups to consider: Can you test your materials in different temperatures as you listed? Why do you think this?..." (Lesson 4, page 21). This feedback will strengthen students' performance of the planning and carrying out investigations SEP.
- Lesson 5, Part C, Advance Sense-making of the Anchor, Step #8: "Collect Student Artifact 5.3 [CER] and use it to formatively assess student learning. Provide each student with written feedback on their argument by completing the final step of the artifact sheet when you review it. Refer to the following table for assessment and scoring guidance that will help you interpret students' performance as related to the three dimensions" (Lesson 5, page 18).

Students have multiple, explicit opportunities to incorporate feedback they receive to improve their performance. For example:

- Lesson 2, Part D, Advance Sense-making of Anchor, Step #3: "As needed, provide a little time for students to make changes to their models based on the peer feedback they receive" (Lesson 2, page 21).
- Lesson 3, Part B, Investigation, Step #3: "Teacher Feedback: Review each group's investigation plan and provide verbal feedback on its strengths and weaknesses. Next, allow time for groups to make changes to their plan based on your feedback" (Lesson 3, page 15).
- Lesson 5, Part C, Advance Sense-making of the Anchor, Step # 7: "Allow students the opportunity to revise their claim, evidence, or reasoning on Student Artifact 5.3 after receiving peer feedback. Remind them to make changes to the graphic organizer in a different color" (Lesson 5, page 18).

Suggestions for Improvement

None

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

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)