How Can Containers Keep Stuff From Warming Up or Cooling Down?
EQuIP Rubric for Science Evaluation

Developer/Curriculum: OpenSciEd
Unit Name: How Can Containers Keep Stuff From Warming Up or Cooling Down?
Grade: 6
Date of Review: July 2019
Overall Rating (N, R, E/I, E): E
Category I: NGSS 3D Design Score (0, 1, 2, 3): 2
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 3
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3
Total Score (0–9): 8

Click here to see scoring guidelines

This review was conducted by the Science Peer Review Panel 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**	Extensive
B. Three Dimensions	Adequate	**B. Student Ideas**	Extensive	**B. Formative**	Adequate
C. Integrating the Three Dimensions	Extensive	**C. Building Progressions**	Adequate	**C. Scoring Guidance**	Adequate
D. Unit Coherence	Adequate	**D. Scientific Accuracy**	Extensive	**D. Unbiased Tasks/Items**	Adequate
E. Multiple Science Domains	Adequate	**E. Differentiated Instruction**	Adequate	**E. Coherence Assessment System**	Extensive
F. Math and ELA	Adequate	**F. Teacher Support for Unit Coherence**	Adequate	**F. Opportunity to Learn**	Adequate
		G. Scaffolded Differentiation Over Time	Adequate		

Summary Comments

Thank you for your commitment to students and their science education. Achieve is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully revised after receiving feedback from the first review with the most significant improvements found in the three-dimensional assessments. The unit is strong in several areas, including many opportunities for students to build understanding of the disciplinary core ideas while engaging in practices and using crosscutting concepts to facilitate student thinking. The anchoring phenomenon is relevant and accessible to all students and the use of the engineering design challenge at the end of the unit provides a way for students to demonstrate their three-dimensional understanding built throughout the unit.

During revisions, the developers should pay close attention to including direction for teachers to support all types of learners in the classroom and how each subgroup might benefit from these supports. Also consider providing specific direction for teachers on how feedback might be used to provide opportunities for students to revise their thinking and for teachers to modify their instruction.

It is also important to ensure that prior knowledge from elementary school is built upon to develop student competency in SEPs and CCCs at the grade-appropriate element level. In the feedback that follows, a distinction is made between just using the elements of the SEPs and DCIs and truly developing student capacity over time to engage in the three dimensions at the 6-8 grade band element level.

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.

Category I. NGSS 3D Design

Score: 2

***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)*

I.A. Explaining Phenomena/Designing Solutions: Making sense of phenomena and/or designing solutions to a problem drive student learning.
- Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.
- The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.
- 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 and/or designing solutions to a problem because the anchoring phenomenon is presented in the first lesson and is regularly revisited to add layers of explanation based on student learning.

The materials are organized so that students are figuring out both a central phenomenon (temperature change in different cups) and then designing the solution to a problem ("Cold Cup Challenge"). Both the phenomenon and problem drive the learning across the unit, with the temperature change in the different cups driving Lessons 1–14 and the “Cold Cup Challenge” driving Lessons 15–18. Student learning is focused on supporting students to better make sense of the phenomenon and designing a better solution for the engineering challenge.

Evidence of student learning across the three dimensions in service of making sense of phenomena or designing solutions to a problem can be found in:

- The second paragraph on page 8 of the Teacher Handbook explains how “each OpenSciEd” unit is anchored in a phenomenon or set of phenomena, and strategically integrates the DCIs, SEPS, and CCCs, to create a storyline path”. It continues by stating that “the class, as a whole, incrementally develops ideas over time, motivated by questions about the phenomena in the world, where each step is an attempt to address a question or a gap in the class’s current explanatory model, developing, using and extending parts of the DCIs, SEPs, and CCCs as needed.
- The infographic explaining the OpenSciEd Instructional Model can be found on page 11 of the Teacher Handbook which shows how the five OpenSciEd routines are leveraged to make sense of phenomena.
- On page 12 and 19 of the Teacher Handbook, the Anchoring Phenomenon and Problematizing Routines are described respectively where students are presented “with aspects of the phenomenon they have not yet figured out how to explain” in order to drive the learning.
- In Lesson 1, students “observe an iced drink in a regular cup warming up more quickly compared with an iced drink in a fancy cup” as the anchoring phenomenon of the unit. (Teacher Edition, pages 41 and 42). Lessons 2–14 that follow each provide a piece of the puzzle to help explain the anchoring phenomenon and Lessons 15–18 use these scientific concepts to design a solution to the engineering “Cold Cup Challenge.”
- A Driving Question Board is developed related to the anchoring phenomena in Lesson 1 (Day 3), is revisited again in Lesson 8 when updating progress trackers (Teacher Edition, page 176), and at the end of the unit in Lesson 18 (Day 3).
- A progress tracker is created in student notebooks during Lesson 2 (Teacher Edition, page 73) to show progress towards figuring out the anchoring phenomenon and is continually added to in later lessons including Lesson 4 (Teacher Edition, page 111), Lesson 6 (Teacher Edition, page 141), Lesson 8 (Teacher Edition, page 176), Lesson 10 (Teacher Edition, page 199), Lesson 12 (Teacher Edition, page 236) and Lesson 18 (Teacher Edition, page 323).
- Lesson-level phenomena were investigated as students tested cup features with the Hot Water Test (Lesson 4), Water Droplet Test (Lesson 5), and the Light and Temperature Test (Lessons 7 & 8).
- Lesson-level phenomena were investigated as students tested particle movement of water with the Water Bath Lab (Lesson 9), the Food Coloring Lab (Lesson 10), and Marble Simulation (Lesson 13).
- Navigation Routines are used in each lesson to review what was figured out in previous lessons and to introduce the purpose and motivation for the next lesson. For example, on page 229 of the

Teacher Guide, the last paragraph of the Navigation section prompts the teacher to "motivate the need for further investigation" and tell them "we need to gather more evidence about the kinetic energy of particles.

- At the end of the Lesson 10 on page 207 of the Teacher Edition, students are prompted to complete an exit ticket to answer the question "what could cause the motion of particles to move more?" as a problematizing routine to motivate the next lesson.

Suggestions for Improvement

There are many missed opportunities to revisit the Driving Question Board to make visible the student questions that have been answered throughout the series of lessons and to elicit new questions that may arise from new lessons in order to drive the learning. For example, at the end of Lesson 10, this process could have been used instead of students answering a question as an exit ticket as a method of problematizing what needs to be figured out in the next lesson. Or at the start of Lesson 12, instead of prompting teachers to "tell students" that "we need to gather more evidence about the kinetic energy of particles" the DQB could be used to have students help find their own need for further investigation. Prior experiences are the main driving force for learning as the storyline progresses, but student questions could be leveraged more as another way to create the need or motivation for learning.

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

Provides opportunities to *develop and use* specific elements of the SEP(s).

Provides opportunities to *develop and use* specific elements of the DCI(s).

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. Evidence is found throughout the unit of students engaging in grade-appropriate elements that are in service of students making sense of phenomena and/or designing solutions to problems.

Science and Engineering Practices (SEPs): Adequate

The reviewers found adequate evidence that students have the opportunity to use the SEPs in this unit because each lesson provides one or more opportunities to engage in an SEP and multiple SEPs are used throughout the unit. However, students are often asked to use the SEP without the necessary scaffolds to develop this practice over time. The only SEP that is developed at grade-level throughout the unit is **Using**

and Developing Models. The SEP **Planning and Carrying Out Investigations** is developed, but not at grade level. The other SEPs are only used instead of being developed over time.

Asking Questions and Defining Problems

- Evidence of student use of the 6–8 grade band element *Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information* is found when:
    - Students write "one question per note card and try to write open-ended questions to post to the DQB" about the anchoring phenomenon after creating their initial models and a classroom consensus model (Teacher Edition, page 58).
    - Students ask questions in their notebooks in a "notice and wonder chart" when they engage with the "hot and cold liquids simulation" found in Lesson 11 (Teacher Edition, page 213).
- Partial evidence of student use of the 6–8 grade band element ~~*Define a design problem*~~ *that can be solved through the development of an object, tool, process or system includes multiple criteria and constraints including scientific knowledge that may limit possible solutions* is found when:
    - Students brainstorm criteria and constraints that they think should be included to measure the success of their cup designs in Lesson 15 (Teacher Edition, page 287). However, students are later given the design problem, criteria and constraints in the design packet handout provided in Lesson 16 (Teacher Edition, page 302).

Using and Developing Models

- Evidence of students developing their ability over time to engage in the 6–8 grade band element *Develop and/or use a model to predict and/or describe phenomena* is found in the evidence provided below. The evidence supports the development of this SEP over time since students are provided supports in earlier lessons in order to build their capacity to develop models and independently use this practice at the 6-8 grade band element level on their own by the end of the unit.
    - "Students work individually to draw systems models to explain why the water in the regular cup warms up more quickly than the water in the fancy cup" and then convene in a scientists circle to "develop a consensus model to explain why the two cup systems work the way they do" (Teacher Edition, page 42).
    - Teachers facilitate the whole group to "generate a list of important parts of the cup systems and record on a whiteboard or chart paper." (Teacher Edition, page 49).
    - Students "work with a shoulder partner to share their model. Each partner should have 1 minute to share their thinking, then they should switch so the other partner has time to share. (Teacher Edition, page 54).
    - Students participate in a gallery walk in order "to (1) wonder about the different mechanisms that cause the thing inside to warm up or cool down and (2) identify patterns in structural features that seem to be important for slowing or stopping this temperature

change" (Teacher Edition, page 57). This is then applied to student models in their progress trackers.
    - Students are given multiple opportunities to revise their thinking and models using the progress tracker in student notebooks. For example, in Lesson 3, students "update their Progress Tracker with words and pictures that indicate what they have learned so far about the lesson question" (Teacher Edition, page 85).
    - Students draw in their notebook what they think particles are doing in cold water and then compare their models with a partner. The teacher then facilitates a class discussion to generate and share ideas of how the class will "represent greater and lesser particle movement in a substance that they think is consistent with the evidence they have collected" (Teacher Edition, page 205).
    - In the summative assessment, students are to model "what happens when ice comes into contact with the skin" and "account for particles of the ice pack and particles for the skin, how the particles are moving in each system based on their temperatures." "This assessment leverages the following model ideas from Lessons 7 through 14" (Teacher Edition, page 265).
- Evidence of student use of the 6–8 grade band element *Evaluate limitations of a model for a proposed object or tool* is found when:
    - Teachers are prompted to "motivate an explicit conversation about the limitations of the previous models with the chips to consider how modifying the model to use marbles can help them account for a different aspect of the phenomenon" (Teacher Edition, pages 135 and 137).
- Evidence of student use of the 6–8 grade band element *Develop a model to describe unobservable mechanisms* is found when:
    - Students develop models in Lesson 10 to explain the movement of different temperature water molecules and then refine the models in Lesson 11 to include the concept of kinetic energy (Teacher Edition, page 216).
- Evidence of student use of the 6–8 grade band element *Develop and/or use a model to generate data to test ideas about phenomena in natural or designed systems, including those representing inputs and outputs, and those at unobservable scales* is found when:
    - Students use online simulations in Lessons 11, 12, and 13 to develop a deeper understanding of and investigate particle motion (Teacher Edition, pages 213–214, 229–232, 245–248).
    - Students use marbles to simulate particle collisions in gases and liquids (Teacher Edition, page 248).

Planning and Carrying Out Investigations

- The reviewers found partial evidence of students developing their ability over time to engage in the 3-5 grade band element *Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled ~~and the number~~*

~~of trials considered~~ . However, this SEP is not developed at the appropriate 6-8 grade band element level.

- Students collaboratively plan and are provided teacher support to set up a fair test to investigate the cup features including lids, materials, and single vs. double walls during the Lesson 2 investigation on pages 68–70 of the Teacher Edition. However, students do not yet identify variables and controls.
- Students use a handout to support the collaborative planning of an investigation for the Hot Water Tests for "Lid Lab 1" and "Lid Lab 2" to test the role of the lid and the double walls in keeping liquids hot in the Lesson 3 investigation on page 86 of the Teacher Edition. Teachers help to "develop vocabulary for variables" and are provided prompts to help "discuss the words independent variable, dependent variable, and controlled variables in the context of the investigation from Lesson 2" (Teacher Edition, page 87).
- Students carry out their collaboratively planned investigation from Lesson 3 during Lesson 4 (Teacher Edition, pages 98 and 103). Teachers are prompted to tell students to consider what might happen if "we ran even more trials under the same conditions". However, the number of trials was not considered during the planning of the investigation.

- Evidence of students use of the 6–8 grade band element *Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meet the goals of the investigation* is found when:
  - Students conduct the "Water Droplet Investigation" in Lesson 5 to test whether the water that forms from condensation comes from inside or outside of the cup (Teacher Edition, pages 121–122).
  - Students conduct the "Light and Temperature Investigations" (Student Edition, pages 31–32) using the procedures in the student handout to determine if light affects the temperature of the water inside the system (Teacher Edition, page 167).
  - Students conduct the "Water Bath Investigation" in order to gather evidence of how heat or cold move across the walls of the cups (Teacher Edition, pages 187–189).
- Evidence of students use of the 6–8 grade band element *Collect and produce data to serve as the basis for evidence to answer scientific questions or test design solutions under a range of conditions* is found when:
  - Students "begin the Regular Light and Temperature Test and the Price Checktest while they wait 12 minutes for the results from the Bright Light and Temperature Test". Students also test their first cup design with "Diameter Test and Environmental Impact Test" (Teacher Edition, page 305).

Analyzing and Interpreting Data

- Evidence of students use of the 6–8 grade band element *Analyze and interpret data to provide evidence for phenomena* and the 6–8 grade band element *Analyze and interpret data to determine similarities and differences in findings* is found when:
  - Students collect data on cup features and share with the class in the Lesson 2 investigation in order to analyze and try to find patterns (Teacher Edition, pages 71–72).

- Evidence of students use of the 6–8 grade band element *Apply concepts of statistics and probability (including mean, ~~median, mode, and variability)~~ to analyze and characterize data, ~~using digital tools when feasible~~* is found when:
    - Students calculate the average or mean of a set of numbers from the set of data collected in Lesson 4 when investigating the functions of the lid (Teacher Edition, page 99).
    - Students analyze the data from the Lesson 8 "Light and Temperature Investigations" and teachers are prompted to reinforce the role of averaging data and identification of outliers in the "Supporting Students in Engaging in Analyzing and Interpreting Data" callout on page 171 of the Teacher Edition.

Constructing Explanations and Designing Solutions

- Evidence of students use of the 6–8 grade band element *Apply scientific ideas, principles, and/or evidence to construct, revises and/or use an explanation or conclusion* is found when:
    - Students construct an explanation about why food coloring spreads out more in hot water in Lesson 11 (Teacher Edition, page 217).
- Evidence of students use of the 6–8 grade band element *Apply scientific ideas or principles to design, construct, and/or test a design of an object~~, tool, process, or system~~* is found when:
    - Students look at existing designs of cups that keep drinks cold to help them develop ideas for their own design solution (Teacher Edition, pages 287–289).
- Evidence of students use of the 6–8 grade band element *Optimize performance of a design by prioritizing criteria, making trade-offs, testing, revising, and retesting* is found when:
    - Students evaluate their initial design solutions at the end of Lesson 16 (Teacher Edition, page 306) and then modify their designs based on test results from Lesson 17 (Teacher Edition, pages 309–310) to improve the features to better slow energy transfer in Lesson 18 (Teacher Edition, pages 312–316).

Engaging in Argument with Evidence

- Evidence of students use of the 6–8 grade band element *Construct, use, and/or present an oral and written argument supported by empirical and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem* is found when:
    - Students provide evidence from their investigations to support a claim chosen from those listed in the "Cold Lemonade on a Hot Day" assessment at the end of Lesson 5 to explain the phenomenon of "droplets on the outside of the pitcher of lemonade" (Teacher Edition, page 126). Students are prompted to explain why they agree with the claim but are not expected to use scientific reasoning.
    - Students are prompted to add a claim supported with evidence and reasoning of what "causes the temperature of the liquid inside a closed cup system to change" when modeling in their notebooks for Lesson 7 (Teacher Edition, page 159).
    - Students create an argument to support their understanding of the direction of energy transfer in Lesson 14 when the "turn to a partner and use our observations and data to make an argument for what moved (heat or cold?) to cause the butter to melt, and in what direction it moved" (Teacher Edition, page 263). Students are prompted to "use

what they have figured out previously to help us explain our observations" as their scientific reasoning (Teacher Edition, page 263).

Obtaining, Evaluating, and Communicating Information

- Evidence of students use of the 6–8 grade band element *Critically read scientific texts adapted for classroom use to determine the central ideas and/or obtain scientific and/or technical information to describe patterns in and/or evidence about the natural and designed world(s)* is found when:
    - Students use the James Joules article, the dissolving candy video demonstration and the food color lab results to communicate in their notebooks "what they think the particles are doing in cold water" and then "what these particles will look like later as the cold water begins to warm up" (Teacher Edition, page 205).
    - Students use information from scientific texts to evaluate the function of cup features for their cold cup challenge and then prepare posters to construct explanations and share their learning with the rest of the class of how to minimize energy transfer in Lesson 15 (Teacher Edition, page 286).

Disciplinary Core Ideas (DCIs): Extensive

The reviewers found extensive evidence that students have the opportunity to use and develop the DCIs in this unit because students progressively engage in deeper understanding and sense-making of the scientific ideas necessary to explain the anchoring phenomenon. Students then apply their understanding of these core ideas while using the Engineering DCIs to design a solution to the cold cup engineering challenge.

PS1.A Structure and Properties of Matter

- Evidence of students developing the 6–8 grade band element *Gases and liquids are made of molecules or inert atoms that are moving about relative to each other* and the 6–8 grade band element *In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations* is found when:
    - In Lesson 4, students develop a particle model of liquids and gases to explain why mass is leaving during their investigations.
    - In Lesson 5, students construct an argument that water forming on the outside of the cup comes from the air in the form of condensation.
    - In Lesson 6, students develop a particle model to explain how water molecules leave the cup system.
    - In Lesson 10, students are prompted to develop particle models to explain the differences of particle motion due to temperature using their investigation results from a food coloring lab and their reading about Joule's Experiment.
    - In Lesson 12, students manipulate a computer model of matter to show how matter is affected by changes in energy.

  - In Lessons 15-18, students use their knowledge of properties of matter built throughout the unit in order to design a solution for the cold cup engineering challenge.
- Evidence of students developing the 6–8 grade band element *The changes of state that occur with variations in temperature ~~or pressure~~ can be described and predicted using these models of matter* is found when*:*
  - In Lesson 6, students develop a particle model to explain how water molecules leave the cup system.
  - In Lesson 10, students develop particle models to explain the differences of particle motion due to temperature.
  - In Lessons 11, 12, and 13, students interact with an online simulation that shows particle motion of liquid at different temperatures.
  - In Lessons 15-18, students use their knowledge of properties of matter built throughout the unit in order to design a solution for the cold cup engineering challenge.

PS3.A Definitions of Energy

- Evidence of students developing the 6–8 grade band element *The term "heat" as used in everyday language refers both to thermal energy (the motion of atoms or molecules within a substance) and the transfer of that thermal energy from one object to another. In science, heat is used only for this second meaning: it refers to the energy transferred due to the temperature difference between two objects* is found when:
  - In Lesson 1, students model the anchoring phenomenon and ask questions about the change of temperature of the water inside the cups.
  - In Lesson 2, students investigate the temperature change of the liquids inside of the cups.
  - In Lessons 3 and 4, students model how the structures and functions of the cup system affect the temperature change of the substance inside the cups and investigate how the lid words to slow the temperature change.
  - In Lesson 10, students develop particle models to explain the differences of particle motion due to temperature.
  - In Lessons 11, 12, and 13, students interact with an online simulation that shows particle motion of a liquid at different temperatures.
  - In Lessons 15–18, students use their knowledge of thermal energy transfer built throughout the unit in order to design a solution for the cold cup engineering challenge.
- Evidence of students using the 6–8 grade band element *Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the type, states, and amounts of matter present* is found when:
  - In Lesson 12, students use online simulations to investigate and analyze data to mathematically represent the relationships to figure out that temperature is a measure of the average kinetic energy of the particles in a substance and the total kinetic energy of a substance is the sum of the kinetic energy of all the particles in the substance.
  - In Lessons 15–18, students use their knowledge of temperature and the total energy of a system in order to design a solution for the cold cup engineering challenge .

PS3.B Conservation of Energy and Energy Transfer

- Evidence of students using the 6–8 grade band element *When the motion energy of an object changes, there is inevitably some other change in energy at the same time* is found when:
  - During the marble activity in Lesson 13, students explain this concept in their chart in the column "How does this connect to what can cause changes in the kinetic energy of the particles in the cup system?"
- Evidence of students developing the 6–8 grade band element *The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, ~~the size of the sample~~, and the environment* is found when:
  - In Lesson 4, students investigate how the lid affects the temperature change in the cups.
  - In Lesson 9, students investigate how the temperature outside of the cup system interacts with the walls of the cup and affects the temperature inside of the cup system.
  - In Lessons 15–18, students use their knowledge built throughout the unit about how matter and the environment (design features of the cup) affect the temperature change and apply this in order to design a solution for the cold cup engineering challenge.
- Evidence of students developing the 6–8 grade band element *Energy is spontaneously transferred out of hotter regions or objects and into colder ones* is found when:
  - In lesson 14, after the butter demonstration students develop models and construct written arguments describing how energy spontaneously transfers out of hotter regions or objects into colder ones.
  - In Lessons 15–18, students use their knowledge built throughout the unit of energy spontaneously transferring out of hotter regions into colder ones in order to design a solution for the cold cup engineering challenge.

PS4.B Electromagnetic Radiation

- Evidence of students developing the 6–8 grade band element *When light shines on an object, it is reflected, absorbed, or transmitted through the object depending on the object's material ~~and the frequency (color) of the light~~* is found when:
  - In Lesson 8, students carry out investigations to test the interaction between light and the cup surface in the warming the liquid inside the cups.
  - In Lessons 15–18, students use their knowledge of how light interacts with the cup system in order to design a solution for the cold cup engineering challenge.

ETS1.A Defining and Delimiting and Engineering Problem

- Evidence of students using the 6–8 grade band element *The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions* is found when:
  - In Lesson 15, students brainstorm criteria and constraints for the cold cup challenge.
  - In Lesson 16, students are provided the engineering problem and discuss the list of criteria and constraints for developing their design solution. However, at the middle school level,

students should play a role in determining the criteria and constraints for the design challenge.

ETS1.B Developing Possible Solutions

- Evidence of students using the 6–8 grade band element *A solution needs to be tested, and then modified on the basis of the results, in order to improve it* is found when:
  - In Lesson 16, students develop ideas for their initial design solution for the cold cup challenge and test design features.
  - In Lesson 17, students design an improved solution based on test results from Lesson 16 and then carry out investigations to test their design solutions.

Crosscutting Concepts (CCCs): Adequate

The reviewers found adequate evidence that students have the opportunity to use CCCs in this unit as students engage in the practices. Although support is provided to develop student ability to engage with CCCs, the development is done at the 3-5 grade band element level. However, there are other opportunities for students to use additional CCCs throughout the unit at the appropriate 6-8 grade band element level.

System and System Models

- The reviewers found evidence of students developing their ability over time to engage with this CCC at the 3-5 grade band element level. However, partial evidence was found of students using this element at the 6-8 grade band level.
  - The consensus models developed in Lesson 2 begins to develop this element using the Driving Question Board but is aligned to the 3-5 grade band element *A system can be described in terms of its components and their interactions* when it shows the cup system to be made up of walls/layers, lid/straw, water and ice inside with interactions related to energy transfer. (Teacher Edition, page 59).
  - As students discuss the class results to the Lesson 2 investigation, teachers are prompted to guide student understanding towards making sense "of the role of each part of the system" in "Supporting Students in Developing and Using Systems and System Models" callout. The purpose of this discussion is to "generate an initial list of cup features that have evidence to support that they affect how well the system works (Teacher Edition, pages 71–72). However, this is evidence of the 3-5 grade band *A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.*
  - In Lesson 4, partial evidence is found of the 6-8 grade band element *Models can be used to represent systems ~~and their interactions~~—~~such as inputs, processes, and outputs~~—and ~~energy,~~ matter, ~~and information~~ flows within systems* when students update their Progress Trackers to include particle movement between liquid and air in the cup system models (Teacher Edition, page 112).
  - In Lesson 7, students develop models to "show how you think each of [light and heat] interacts with the closed cup system and how those interactions could cause the

temperature of the liquid inside the system to change" (Teacher Edition, page 158). This evidence is aligned to the 3-5 grade band element *A system can be described in terms of its components and their interactions* since it shows the cup system to made up of walls/layers, lid/straw, water and ice inside with interactions related to energy transfer.

- In Lesson 8, students construct their own models "to represent their ideas about what happens to the light as it encounters the cup wall" and "choose the representation (i.e., dashed arrow) they want to use to show amounts of light doing different things" (Teacher Edition, Page 174). However, this is aligned to the 3-5 grade band element *A system can be described in terms of its components and their interactions.*
- In Lesson 10, students refine their models from the Food Coloring Lab to include kinetic energy. This provides partial evidence of the 6-8 grade band element *Models can be used to represent systems ~~and their interactions—such as inputs, processes, and outputs~~—and energy, ~~matter, and information~~ flows within systems.*
- In Lesson 15, teachers are prompted to facilitate the development of several class consensus models while students offer ideas in a scientists circle to represent "why air pockets keep the drink cooler for longer", "why double-walls keep the drink cooler for longer", and "how radiation warms a drink" (Teacher Edition, pages 293-294). Students are provided a handout without illustrations called "Final Cup Consensus Model" in order to support the development of consensus models for each mechanism of energy transfer into the cup system. However, students do not develop systems models independently in order to demonstrate their ability to use this CCC at 6-8 grade band element level.

Structure and Function

- The reviewers found evidence of students developing their ability over time to engage with this CCC at the 3-5 grade band element level. However, partial evidence was found of students using this element at the 6-8 grade band level.
- is found when:
    - Students identify the structures and their possible functions when creating initial and consensus models in Lesson 1 (Teacher Edition, pages 54–55) and then test some of those features during the investigation in Lesson 2 (Teacher Edition, pages 69–71). However, this is evidence of students using the 3-5 grade band element *substructures have shapes and parts that serve functions.*
    - Students model the cup system to "account for the data they collected about how the % of incoming light that reflected and transmitted light differed between the cups and how those differences affected the changes in water temperature" in Lesson 8 (Teacher Edition, page 174). This is partial evidence of the 6–8 grade band element *~~Complex and microscopic structures and~~ systems can be visualized, modeled, and used to describe how their function depends on ~~the shapes,~~ composition~~, and relationships among its parts~~; therefore, ~~complex natural and~~ designed structures/systems can be analyzed to determine how they function.*

- In Lesson 15, teachers facilitate "a whole class record of what we know, and the features we want to know more about" (Teacher Edition, page 288). This provides evidence of students using the 3-5 grade band element *substructures have shapes and parts that serve functions.*
- In Lesson 17, students "must identify at least 3 design features they believe will slow energy transfer into the cup system. They are prompted to describe which feature they are modifying, where this modification will improve the cup's performance (which test), and how they believe it will help" (Teacher Edition, page 314). This provides evidence of students using the 3-5 grade band element *substructures have shapes and parts that serve functions.*

- Evidence of students using the 6–8 grade band element *Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used* is found when:
    - In Lesson 16, students identify the design features in their initial design and explain to a partner how it works to slow energy transfer (Teacher Edition, page 302).

Patterns

- Evidence of students using the 6–8 grade band element *Graphs, charts and images can be used to identify patterns in data* is found when:
    - Students are prompted to identify patterns in the class data after completing a fair test investigation of a feature of a cup in Lesson 2 (Teacher Edition, page 71).
    - Teachers are prompted in Lesson 8 to support students in looking for patterns "as they analyze their data and to avoid getting too focused on a single data point" in the "Supporting Students in Developing and Using Patterns" callout on page 172 of the Teacher Edition.
    - Teachers are prompted to ask students "What patterns do you notice in the data?" and "What patterns do you notice about the final temperature measurements" during the Lesson 9 "Water Bath" investigation (Teacher Edition, page 189).
- Partial evidence of students using the 6–8 grade band element *Patterns can be used to identify cause-and-effect relationships is* found when:
    - Students are prompted in Lesson 2 to use the "patterns from the data analysis process" in their model trackers to explain what they have figured out. Teacher are prompted to explicitly cue students to think "about patterns and systems" to help them generate more focused explanation and/or models (Teacher Edition, page 73). Teachers then facilitate a discussion around patterns to help students understand how these patterns point to "specific cup features that help keep a drink cold" (Teacher Edition, page 74). However, teaches are not prompted to use the words cause-and-effect relationships within the discussion.
- Evidence of students using the 6–8 grade band element *Patterns in rates of change and other numerical relationships can provide information about ~~natural and~~ human-designed systems* is found when:

- Students are prompted to identify patterns in the cold cup challenge results to choose the cups that work best to minimize thermal energy transfer (Teacher Edition, page 323).

Matter and Energy

- Evidence of students using the 6–8 grade band element *Matter is conserved because atoms are conserved in physical and chemical processes* is found when:
  - The teacher is prompted to "lead a building understandings discussion about the mass data" in the "Making Sense of Mass Loss Data" section on page 103 of the Teacher Edition. The purpose of this discussion is to "establish which system(s) lost the most matter, where matter comes from, and where it went."
- Evidence of students using the 6–8 grade band element *The transfer of energy can be tracked as energy flows through a designed ~~or natural system~~* is found when:
  - Students are prompted to revise their cup system models to include the concept of kinetic energy in Lesson 14. They are asked to explain what is happening "between the air and the wall" and "between the wall and the water" with their table groups (Teacher Edition, page 264). The sample model provided shows an arrow for the "energy flow from hotter matter to colder matter".
  - On page 138 of the Teacher Edition, support is provided to teachers on how to use the marbles to "track matter flow into or out of the cup system." They are guided to support students in using the "CCC as a lens to help students focus on making connections between the cups with and without lids."

Cause and Effect

- Evidence of students using the 6–8 grade band element *Cause-and-effect relationships may be used to predict phenomena in natural or designed systems* is found when:
  - Teachers are prompted to support students to move beyond surface level patterns to thinking more about the mechanisms (causation) when constructing models related to the Lesson 8 "Light and Temperature Investigation" in the "Supporting Students in Developing and using Cause and Effect" callout on page 172 of the Teacher Edition.

Scale

- Evidence of students using the 6–8 grade band element *Phenomena that can be observed at one scale may not be observable at another scale* is found when:
  - Teachers are prompted to say "We just figured out something really important about something we cannot even see!" when they are summarizing class consensus on models students have drawn about water particle movement in Lesson 10 (Teacher Edition, page 207).
  - In Lesson 11, the "Supporting Students in Developing and Using Scale, Proportion, and Quantity" callout provides support for teachers on how to emphasize this element of scale when they are trying to figure something out using models and simulations.

Suggestions for Improvement

SEPs

In order to receive an extensive rating for DCIs, teachers must develop student competency over time to engage in more than one SEP for the length of this unit at the 6-8 grade band element level. All of the other SEPs are used instead of developed or are not developed at the appropriate grade level.

DCIs
N/A

CCCs
In order to receive an extensive rating for CCCs, teachers must move beyond prompting students to use a CCC in specific instances towards developing student understanding of how to call upon the necessary CCCs in order to enhance three-dimensional thinking. The use of the CCCs are clear in most lessons but could be emphasized more in Lessons 10 through 13. The example provided above for **Scale** in Lesson 10 provides a weak connection to this element and teachers or students may not realize that a CCC element is being used here. In Lessons 12 and 13, elements of the claimed CCCs **Patterns** and **Cause and Effect** are used in the lessons but consider providing a "Supporting Students" callout to make clear to teachers the CCC element they should be developing as they facilitate the discussion of the results.

It is also important to ensure that students are developing competency over time in 6-8 grade band CCC elements rather than elements from elementary school.

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 multiple events throughout the material where all students are expected to use grade-appropriate elements of all three dimensions. The three dimensions intentionally work together to help students adequately explain a phenomenon or develop a designed solution to a problem.

On pages 26 through 40 of the Teacher Edition, the three-dimensional lesson-level performance expectations are described for each lesson with assessment guidance for the teacher. This provides a clear reference of how the three dimensions are integrated using color coding and ideas that teachers should look for within student products. These lesson level performance expectations are also provided for each individual lesson in the "What Students Will Do" section of each lesson.

It is important to note that not all dimensions in the LLPEs are used at the 6-8 grade band element level. However, examples of lessons where all three dimensions are integrated at the appropriate grade level include:

- Lesson 8 LLPE: Develop and use models to describe how light transmission through, reflection off, and absorption by cup walls causes changes in the water's temperature (effect). On page 174 of the Teacher Edition, students are prompted to "ask students to first work individually to represent their ideas about what happens to the light as it encounters the cup wall. Give students up to 5 minutes to think about each model and to choose the representation (i.e., dashed arrow) they want to use to show amounts of light doing different things." In the teacher callout, support is provided to help develop student ability to use cause and effect by "coupling this data analysis with constructing models will help students move beyond surface level patterns to thinking more about the mechanisms is important for moving beyond identifying patterns (correlation) to identifying mechanisms (causation)" (Teacher Edition, page 172).
  - This provides evidence of student engagement in the 6–8 grade band SEP Developing and Using Models element *Develop a model to describe unobservable mechanisms.*
  - This provides evidence of the 6-8 grade band DCI PS4.B element *When light shines on an object, it is reflected, absorbed, or transmitted through an object, depending on the object's material ~~and frequency (color) of the light.~~*
  - This provides evidence of student use of the 6-8 grade band CCC Cause and Effect element *Cause and effect relationships may be used to predict phenomena in natural or designed systems.*
- Lesson 10 LLPE: Develop models based on evidence to explain that substances are made of particles that are in motion, and though the individual particles are not visible to the eye, their collective behavior can be observed as more or less movement depending on the substance's' temperature. On page 205 of the Teacher Edition, students are prompted to "individually draw in their notebook what they think the particles are doing in cold water. Then, ask students to draw what these particles will look like later as the cold water begins to warm up to room temperature."
  - This provides evidence of student engagement in the 6–8 grade band SEP Developing and Using Models element *Develop a model to describe unobservable mechanisms.*
  - This provides partial evidence of the 6-8 grade band DCI PS1.A element *~~The changes of state that occur with~~ variations in temperature ~~or pressure~~ can be described and predicted using these models of matter.*
  - This provides evidence of student use of the 6-8 grade band CCC Scale, Proportion and Quantity element *Phenomena that can be observed at one scale may not be observable at another scale.*
- Lesson 16 LLPE: Design a solution for a cup system with features (structures) to slow energy transfer into the liquid inside the cup (function). On page 304 of the Teacher Edition, students are prompted to "make a sketch of their cup designs with their design group, and label at least 3 features of the cup that should slow energy transfer. Once they have a cup design, they should revisit the criteria and constraints to see if they think they will likely meet them given the design."
  - This provides evidence of student engagement in the 6–8 grade band SEP Designing

Solutions element *Apply scientific ideas or principles to design, construct, and/or test design of an object, ~~tool, process,~~ or system.*

- This provides evidence of the 6-8 grade band DCI PS1.A element *The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, ~~the size of the sample~~, and the environment.*
- This provides evidence of student use of the 6-8 grade band CCC Structure and Function element *Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.*

Suggestions for Improvement

Ensuring, especially for CCCs, that elements used and developed by students are at the middle school level would help support student learning.

I.D. Unit Coherence: Lessons fit together to target a set of performance expectations.

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.

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

Rating for Criterion I.D. Unit Coherence: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that lessons fit together coherently to target a set of performance expectations because student experiences and unanswered questions drive the sense-making opportunities in the next lesson. Questions are used to build understanding of core ideas and concepts and students revisit the driving question/unit phenomenon multiple times to take stock of how well they can explain the phenomenon, creating key linkages across the unit.

Although students ask questions and post them to from the Driving Question Board in Lesson 1, students rarely revisit their own original questions or develop new questions once new learning has been acquired in order to drive the learning. Instead, student experiences are the major driver of motivation or need to engage in the next lesson as found in the navigation boxes at the start of each lesson. Navigation Routines are used in each lesson to review what was figured out in previous lessons and to support teachers in introducing the purpose, driving question, and motivation for the next lesson. For example, on page 229 of the Teacher Guide, the last paragraph of the navigation section prompts the teacher to "motivate the need for further investigation" and tell them "we need to gather more evidence about the kinetic energy of particles".

Other evidence of how this criterion is addressed can be found in the Teacher Edition on:

- Page 17, Paragraph 3: The first set of lessons provides investigations that "motivate the need for more systematic investigations to test the various cup features".
- Page 22, Lesson 1: The third bullet point in the purpose of the assessment table cell states that "disagreement about how the drink inside warms up" "will motivate the need for further investigations.
- Page 17, Paragraph 4: The limitations in their models (from lesson set 1) motivate the second lesson set when "students investigate how energy can enter or leave the system"
- Page 17, Paragraph 5: Students apply their understanding of particle collision and energy transfer from Lesson 4 to their models. "They use what they have figured out about mechanisms of energy transfer and design features" from the previous lesson to design, build, test and modify their own cup system.

The developers have provided an explanation of why the driving questions are provided in the Student Guide instead of using student-generated questions as the driving questions. They explain that the Student Guide is optional and indicate that teachers can distribute the lessons from the Student Guide one at a time. However, teachers are not provided an explanation of why distributing the whole Student Guide may create a situation where students do not think their own questions are driving the instruction.

Further evidence of unit coherence can be found when students are prompted to track driving questions, their learning, and revisions to their explanations of phenomena using a Progress Tracker. For example, in the beginning of Lesson 12 (Teacher Edition, page 239) the teachers are prompted to say, "Turn to a new page in your notebook and write the lesson question at the top: How does the motion of particles compare in a sample of matter at any given temperature?" However, it is not apparent if this question has been previously posed by students as one of the questions added to the driving question board in a previous lesson or is posed by the teacher.

Suggestions for Improvement

Although student questions from the Driving Question Board in Lesson 1 are posted to help produce the need or motivation for learning in the unit, there are multiple missed opportunities to revisit the driving question board and elicit new questions to help produce a need for figuring out. As explained in the Using Phenomena in NGSS-Designed Lesson and Units Resource, "The point of using phenomena to drive instruction is to help students engage in practices to develop the knowledge necessary to explain or predict the phenomena. Therefore, the focus is not just on the phenomenon itself. It is the phenomenon plus the student-generated questions about the phenomenon that guides the learning and teaching. The practice of asking questions or identifying problems becomes a critical part of trying to figure something out." This also links to the suggestions found in Criterion 1.A.

I.E. Multiple Science Domains: When appropriate, links are made across the science domains of life science, physical science and Earth and space science.

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

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 although the majority of the unit is focused on Physical Science ideas to explain the anchoring phenomenon, the unit brings in Life Science ideas during the final summative assessment using the CCC of Structure and Function to make connections to a similar and related phenomenon.

The unit primarily focuses on the Physical Science ideas of matter and properties of matter and energy, specifically PS1.A and PS3.B. Students use these science ideas to connect to the Engineering DCIs, specifically ETS1.A, ETS1.B, and ETS1.C, when they develop a design solution. In addition, in this unit, it is appropriate for students to make sense of the phenomenon using only one science domain.

Suggestions for Improvement

In order to receive an extensive rating, a second science domain (not including engineering) would need to be more fully integrated into the lessons of the unit in order to explain a similar but related phenomenon to the anchoring phenomenon with crosscutting concepts intentionally and explicitly used to make connections across the science disciplines addressed in the unit.

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 mathematics, English language arts (ELA), history, social studies, or technical standards because direct connections made to CCSS Math and CCSS Literacy standards are found at the end of multiple lessons.

There is evidence of grade-appropriate Math and ELA standards purposefully incorporated into the lessons with teacher support to help students make these connections:

- Connections are made to CCSS ELA Literacy.SL.6.1c *Pose and respond to specific questions with elaboration and detail by making comments that contribute to the topic, text, or issue under discussion* in the "Additional Lesson 1 Teacher Guidance" callout with teacher support on how to facilitate getting students to explain how "their question is linked to someone else's question" (Teacher Edition, page 65).
- Connections are made to CCSS ELA Literacy.RST.6-8.3 *Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks* in the "Additional Lesson 3 Teacher Guidance" callout with teacher support on how to work towards this standard when students generate investigation plans and carry out their investigations (Teacher Edition, page 89 and 113).
- Connections are made to CCSS.Math.Content.6.NS.C.5 related to positive and negative numbers and CCSS.Math.Content.6.SP.A.3 related to the measure of center for a numerical data set are made in the "Additional Lesson 4 Teacher Guidance" section of the Teacher Edition (pages 113–114).
- Connections are made to CCSS.Literacy.W.6.1.a related to making claims and organizing reasons and evidence clearly in the "Additional Lesson 7 Teacher Guidance" section (Teacher Edition, page 160).
- Connections are made to CCSS.Math.Content.6.RP.A.3.c related to finding a percent of a quantity in the "Additional Lesson 8 Teacher Guidance" section (Teacher Edition, page 177).
- Connections are made to CCSS.Literacy.RST.6-8.9 related to comparing and contrasting information from multiple resources in the Additional Lesson 10 Teacher Guidance" section. (Teacher Edition, page 207)
- Connections are made to CCSS.Math.Content.6.SP.A.2 related to answering statistical questions in the "Additional Lesson 12 Teacher Guidance" section (Teacher Edition, page 237).

Suggestions for Improvement

In order to receive a rating of Extensive for this criterion, students need to be provided multiple, varied opportunities for high-level verbal discourse. This would include discourse in a variety of formats and scenarios such as partners, small groups, formal presentations, and other technology-enhanced opportunities. Although this unit does allow for partner, small group, and whole class discussion, the discourse opportunities are repetitive and lack formal and technology-enhanced opportunities. Writing assignments would also need to be more varied in structure and purpose using higher levels of rigor. Reading materials would need to go beyond the articles provided to include other opportunities such as news articles, journal articles, infographics, and/or websites of scientific entities.

Overall Category I Score (0, 1, 2, 3): 2

Unit Scoring Guide – Category I
Criteria A–F

How Can Containers Keep Stuff From Warming Up or Cooling Down?
EQuIP Rubric for Science Evaluation

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

Score: 3

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*

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.

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

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

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 engagement is created through direct student experiences with the phenomena throughout the unit and is structured in a way that values the funds of knowledge that students bring to school from their homes and communities.

The anchor phenomenon used is relatable to all students since we all drink from cups and have experienced ice melting and our drinks warming up on hot days. The lessons also provide support to teachers and students for connecting their experiences and questions to the targeted learning about the phenomena.

Evidence of this can be found in:

- The anchoring phenomenon of iced drinks warming in a cup is an observable event that happens in class on day 1. Many students will have prior experience with this phenomenon and these types of cups from their everyday lives. Students also identify related phenomena at home at the end of day 1 to “broaden their thinking to related phenomenon beyond the initial two cups” (Teacher Guide, pages 42 & 52).
- Teachers are prompted to introduce the anchoring phenomenon by sharing a “story about your iced drink warming up in a regular plastic cup” and to “revise slide A to match the story you want to use to situate the phenomenon.” Additional Guidance is provided about modifying the anchor in a callout in order to support teachers in keeping the scenario “meaningful” for students (Teacher Guide, page 46).

- Students are prompted to develop a related phenomena poster with similar systems they have from their own experiences in Lesson 1 (Teacher Edition, page 55).
- Teachers are prompted to create a Driving Question board in Lesson 1 based on student questions about the phenomena (Teacher Edition, page 57).
- In Lesson 5, students "connect to related experiences involving condensation." The "Attending to Equity" callout suggests to "leverage students' prior experiences with condensation as a valuable source of observational data alongside the classroom-collected data to support or refute claims" (Teacher Edition, page 123).
- Lesson-level phenomena were investigated first hand as students tested cup features with the Hot Water test (Lesson 4), Water Droplet Test (Lesson 5), Light and Temperature Test (Lesson 7 & 8), and Water Bath Test (Lesson 9).

Suggestions for Improvement
N/A

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 respond to feedback on their ideas. The teacher is supported to act as an expert facilitator, drawing out student ideas while coordinating progress toward targeted learning.

The learning experiences provided in this unit require students to use their ideas and cite shared ideas of others to build upon prior understanding. Students demonstrate new thinking based on peer and teacher feedback as well as personal reflection in their Progress Trackers. In the "Attending to Equity" callout on page 73 of the Teacher Edition, an explanation is provided of how the Progress Tracker "is a space for students to be creative and to synthesize learning in their own words and drawings."

Evidence of teacher support about how to leverage student ideas in these contexts can be found in the Teacher Handbook on:

- Page 8: The last sentence of paragraph two states that the storyline approach used by OpenSciEd creates a classroom culture that "supports students' agency in sensemaking: WE figure out the science ideas and WE put those ideas together over time."
- Page 12: An explanation is given of how the Anchoring Phenomenon Routine is used for "students to voice their initial ideas" through "writing, drawing and sharing their own initial models,

explanations or design solutions." It also helps to identify "the areas of agreement and disagreement in students' ideas," "create a shared classroom representation of an initial class consensus model," and "a Driving Question Board".

- Page 32: Section I describes how to support discussion in the classroom. It states that "discussion is the key to a classroom learning community in which all students' ideas are shared and valued." On page 34, Section I continues to provide instructional strategies for "making participation equitable during discussions" and "questioning strategies to support discourse" for various types of discussions.
- Page 49: A guide is provided describing when and how to facilitate peer feedback. Examples are provided about ways to organize peer review, including the Sticky Note protocol from Ambitious Science Teaching and through the use of SEP-specific rubrics found within each OpenSciEd unit.

Examples of students sharing ideas, building upon the ideas of others, and responding to feedback can also be found within the lessons including:

- Students "create an Ideas for Investigations poster and record the class thoughts on how to figure out the answers to our initial questions as we move forward" (Teacher Edition, pages 43 and 60).
- In the Teacher Edition, students turn and talk with a shoulder partner multiple times throughout the unit (Teacher Edition, pages 46, 47, 81, 119, 151, 185, 186, 189, 199, 200, 204, 205, 213, 229).
- Students gather in a scientist circle several times throughout the unit to "build a sense of shared mission and a community of learners working together." In the scientist circle, students share ideas in order to develop "a more complete explanation of phenomena" (Teacher Edition, pages 47–49, 53–55, 58–60, 120, 123, 141, 189, 235, 260). The Attending to Equity callout on page 53 supports teachers in helping build their classroom community culture where "differences in thinking" between class members will help the class "grow their knowledge together" (Teacher Edition, page 53).
- Strategies for facilitating the Consensus Discussion are provided on page 54 of the Teacher Edition including how to elicit student ideas and how to highlight areas of agreement and disagreement in a respectful manner.
- Gallery Walks are used to share student ideas with the whole class several times throughout the unit including Lessons 1, 14 and 15.
- The formative assessments found in Lesson 6 and 14 have sections for written teacher feedback on student models (Teacher Edition, pages 149 and 231).

Suggestions for Improvement

Consider providing more opportunities for students to demonstrate new thinking based on peer and teacher feedback as well as personal reflection.

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

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

Rating for Criterion II.C. Building Progressions: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because the materials make clear the expected level of proficiency students should have with all three dimensions for the core learning in the unit. The Unit Storyline provides a description of what students will be figuring out in each lesson and how this should be represented using exemplar models.

In addition, each lesson begins with the "Where We are Going and Where We are NOT Going" section that provides a big picture of how student understanding will be built progressively throughout the unit. Information is also provided about how some of the concepts connect to past or future OpenSciEd lessons. Evidence of this includes:

- The section "What should my students know from earlier grades or units?" on page 19 of the Teacher Edition describes the 3–5 elemental levels of SEPs and CCCs and the DCI components from Grades 4 and 5 that the unit build upon.
- On page 96 of the Teacher Edition, the Lesson 4 "Where We are Going and NOT Going" callout provides a more detailed explanation of what students did in 5th grade with particulate modeling of matter in order to build on this understanding "to account for mass change in the cups as water evaporates into the air and then escapes the cup system."
- In the "Additional Guidance" callout on page 100 of the Teacher Edition, it states that teachers "are not introducing any distinction between mass versus weight in this unit" and that this will be introduced in OpenSciEd unit 6.3.
- On Page 105 of the Teacher Edition, teachers are provided specific guidance that "in NGSS, 5th grade students should have developed a particulate model of matter for liquids and gases and used it to explain phenomena such as the gradual disappearance of liquid water in an open system (evaporation)."
- In the "Additional Guidance" callout on page 111 of the Teacher Edition, it provides guidance to teachers on what to do if a student responds or has a question regarding solids being made of particles. It states, "If the ideas of solids begin made of particles isn't suggested from students here, it will be introduced in Lesson 6."
- On page 243 of the Teacher Edition, the Lesson 12 "Where We are Going" callout provides an explanation of the 4th Grade PE PS3-2 that deals with energy transfer in collisions that students may have learned in previous years to be built upon in this lesson. It continues to provide an

explanation of how the lesson will focus on energy and the mechanism of contact forces will be focused on in OpenSciEd unit 8.1.

However, the reviewers did not find specific examples within the unit of how CCCs are built upon the 3-5 grade band element level.

Suggestions for Improvement

In order to receive an extensive rating, there needs to be a clear explanation of how prior learning will be built upon for each dimension. Consider especially adding specific supports of how to build upon the 3-5 grade level CCCs to reach the 6-8 grade elements for this dimension.

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

Rating for Criterion II.D. Scientific Accuracy: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials use scientifically-accurate and grade-appropriate scientific information because all science ideas included in the materials are accurate and there is strong support for teachers to clarify potential alternate conceptions that they (or their students) may have.

Evidence of this can be found:

- On page 20 of the Teacher Edition, the section titled "What are some common ideas students have?" provides common ideas students might share in their thinking.
- All lessons include scientifically-accurate and grade-appropriate information.

Suggestions for Improvement

N/A

II.E. Differentiated Instruction: Provides guidance for teachers to support differentiated instruction by including:

Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.

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

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

Rating for Criterion II.E. Differentiated Instruction: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because a variety of differentiation strategies with guidance are provided to support reading, writing, or math skills that are integral to sense-making. However, the reviewers were not able to find support provided for students who are not proficiently using the CCCs.

The Teacher Handbook provides support on how OpenSciEd integrates differentiated instruction into the units. Evidence of this can be found on:

- Page 38: Explanations and examples from OpenSciEd are provided for differentiation of content (removal or addition of supporting lessons), differentiation of process (grouping and timing), and differentiation of product (using student choice in how to represent their thinking).
- Page 40: A description is provided of where to find differentiation in the OpenSciEd Units including the equity callouts, alternative activity callouts, and additional guidance callouts.

Multiple examples of opportunities for differentiated instruction can be found within the lessons including:

- The "Attending to Equity" callout on page 54 of the Teacher Edition provides a color coding and letter coding strategy to ensure accessibility for any student who may be color blind.
- An alternate activity is provided if students need "practice with interpreting graphs". Teachers are prompted to "consider producing a graphical display of the class data for students to analyze and interpret" (Teacher Edition, page 52).
- The "Additional Guidance" callout provides a strategy for developing vocabulary using a word wall and having students "earn" words when they have a deep understanding of them. The Attending to Equity callout provides a strategy for developing new vocabulary that may benefit multilingual learners by "making connections to cognate words when possible and showing a visual representation of the word" (Teacher Edition, page 56).
- The "Alternate Activity" callout for Lesson 4 provides an alternative to using positive and negative numbers through the use of arrows (Teacher Edition, page 97).
- The "Attending to Equity" callout in Lesson 4 provides a strategy for students to track progress on any technical task in a multistep procedure form by placing a checkmark next to each step as it is completed (Teacher Edition, page 97).
- On page 86 of the Teacher Edition, the "Additional Guidance" callout provides a description of an alternate "generic template that you can use to scaffold students' work as they plan and carry out investigations."
- On page 107 of the Teacher Edition, the "Alternate Activity" callout provides guidance on supporting students who need a deeper understanding of particles in their models using the manipulative model blue and yellow chips to represent molecules.

- On page 125 of the Teacher Edition, the "Alternate Activity" callout provides guidance on differentiating Lesson 5 if students made observations of condensation forming on the underside of the lid in the Lesson 4. Teachers are promoted to address this observation at this point since "students are ready to understand how water droplets form on the underside of the lid in a closed hot cup system".
- On page 187 of the Teacher Edition, the "Alternate Activity" callout provides guidance on three alternate options for the "Water Bath" investigative phenomenon in order to satisfy curiosity about heat and cold moving across the wall of a cup.
- Close reading strategies are provided for the James Joule's Article using comprehension strategies such as reading alone then aloud, highlighting, and modeling thinking (Teacher Edition, page 204).
- In the "Attending to Equity" callout in Lesson 11, a suggestion to increase the rigor of the constructing explanation activity is provided and two Concord Consortium resources are provided for students who need remediation (Teacher Edition, page 217).

Suggestions for Improvement

Consider providing extra support throughout the lessons for students who are struggling to meet performance expectations, guidance on how to determine their understanding at that point in the lesson, and how the suggested support will help students demonstrate progress towards understanding the targeted performance expectations. In particular, providing support for students who aren't making use of CCCs would be very helpful.

Also, consider strategies or resources for students who have already mastered the lesson-level performance expectations while the students who are struggling are provided additional time for remediation and supporting resources. Differentiation ideally would address all types of learners in a way that is meaningful, respectful, relevant and engaging, including English Learners, learners with special needs, learners who read below grade-level, struggling students, and students who have already met the performance expectations.

II.F. Teacher Support for Unit Coherence: Supports teachers in facilitating coherent student learning experiences over time by: 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.). 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: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because students have an opportunity to engage in asking questions that they feel they need to address in upcoming lessons and future investigations. However, those questions do not directly drive subsequent lessons.

In all lessons in this unit, students make progress towards elements of each dimension that help the student also make progress on answering the questions connected to the phenomena. Guidance is provided for teachers on how to connect what is figured out in each lesson to the phenomena and to the next lesson.

Evidence of teacher support for unit coherence can be found in the Teacher Handbook on:

- Page 7: An explanation is provided about how the DCIs are used across three years of middle school within the OpenSciEd units in order to provide "a pathway through which students can coherently build the target DCIs."
- On page 7: An explanation is provided about how the SEPs are used to engage students in developing "new ideas and make new discoveries throughout the storyline." Further explanation is provided about how each SEP is used to develop unit coherence with more supports found in section E.
- On page 8: An explanation is provided about how the CCCs are used to "make connections within and across units".
- On page 11: The infographic of the OpenSciEd Instructional Model provides an explanation of how 5 routines are used to make sense of phenomena. Further explanation of each routine can be found on pages 12 through 19 of the Teacher Handbook.
- Pages 20 and 21: An explanation is provided of how the Driving Question Board is used as a tool to support the Navigation, Putting Pieces Together, and Problematizing routines over the course of the unit.

Evidence of teacher support for unit coherence can also be found within the Teacher Edition including:

- At the start of each lesson, an explanation of "Where we are going and NOT going" is provided to help teachers understand which questions from the driving question board will be answered in this lesson and which ones will be answered in later lessons. This helps support teachers by keeping them focused on the specific pieces of the puzzle students are to figure out in the current lesson.
- Teachers are provided guidance in a Science Notebook callout to support the setting up the science notebook at the start of the unit to accommodate the unit question (presented on Day 3), table of contents, progress tracker (throughout the unit), and page numbering system (Teacher Edition, page 47).
- Teachers are provided guidance on the purpose of the class discussion in Lesson 2 in the Key Ideas callout that states the purpose of the discussion is to "motivate the need to gather additional

evidence on cup features that have inconclusive data" in future lessons (Teacher Edition, page 72).

- In the first paragraph on page 110 of the Teacher Edition, teachers are prompted to "make a record of these on chart paper and save it. You will need to present this record for Lesson 6" in reference to the list of key ideas that the class has figured out up to Lesson 4. A list of ideas is also provided for teacher guidance in facilitating the discussion.
- In the "Where we are NOT Going" section of Lesson 5 on page 118 of the Teacher Edition, teachers are guided NOT to "spend time elaborating on the process of condensation, as it will be further discussed in the next unit of water cycling and weather.
- Teacher guidance for using a word wall and when to add words when students "earn" them is provided at multiple times throughout the unit. For example, page 120 of the Teacher Edition provides guidance for the word condensation in the "Additional Guidance" callout.
- In the "Where we are NOT Going" section of Lesson 6 on page 134 of the Teacher Edition, teachers are guided to not represent the types of gases in the air. "This idea will be developed in OpenSciEd unit 6.3."

Suggestions for Improvement

In order to receive an extensive rating, students need to be provided more opportunities to cultivate new questions at the end of a lesson that lead to future investigations.

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 adjusts supports over time. Supports are provided for all students to engage in the SEPs in ways that not only integrate the other two dimensions, but also explicitly build an understanding and proficiency in the SEP's over the course of the unit.

The instructional materials provide guidance to create learning experiences targeting students with diverse needs and abilities so they can connect to and use to make progress over time toward common learning goals of engaging in the practices and making sense of phenomena or developing solutions to problems. Examples of this can be found:

- On page 23 of the Teacher Handbook, section F describes and provides examples of how the OpenSciEd teacher materials support the transition from "highly scaffolded experiences with crosscutting concepts (CCCs) to limited scaffolding". The example provided shows how question prompts from STEM Teaching Tool #41 is used within the teacher materials to "scaffold student sense-making and discourse". For example, on page 83 of Teacher Edition, a suggested prompt is "What patterns did you notice about the cups' ability to keep water hot?"

- On page 20 of the Teacher Edition, the section called "What modifications will I need to make if this unit is taught out of sequence?" provides insight that scaffolds would need to be provided related if "light interactions with matter" and "asking open ended questions" if Unit 6.1 was not taught first. However, the scaffolds are not provided.
- Teachers are provided support in helping students build capacity with engaging in the SEP Planning and Carrying Out Investigations using callouts, beginning with the first investigation of the cold cup on page 47 of the Teacher Edition. It explains that over the course of the unit, students will learn to "set up more systematic investigation where they identify independent, dependent, and control variables". Teachers are then provided support on how to scaffold engaging students in SEP Planning and Carrying Out Investigations when they begin with setting up a fair test when testing the features of cups in Lesson 2 (Teacher Edition, pages 67–69). They continue in Lesson 3 by focusing students "on getting more systematic in their investigations" (pages 81–82) and in Lesson 4 they pay closer attention to the variables (pages 100–101). However, the reviewers did not find that students built upon prior knowledge from the 3-5 grade band elements to reach the 6-8 grade band elements of this SEP. (See Criterion II.C)
- Teachers are provided support in helping students build capacity with engaging in the SEP Developing and Using Modes in the callout on pages 53–54 of the Teacher Edition. Teachers are prompted that "models are supposed to change as our knowledge grows, therefore students will continue to revise and edit their model over the course of the unit." Evidence was found of instructional strategies provided to support this SEP being developed over time but the reviewers did not find evidence of teacher supports on how to adjust scaffolding to support students differentially over the course of the unit.
    - "Students work individually to draw systems models to explain why the water in the regular cup warms up more quickly than the water in the fancy cup" and then convene in a scientists circle to "develop a consensus model to explain why the two cup systems work the way they do" (Teacher Edition, page 42).
    - Students "work with a shoulder partner to share their model. Each partner should have 1 minute to share their thinking, then they should switch so the other partner has time to share. (Teacher Edition, page 54).
    - Students participate in a gallery walk in order "to (1) wonder about the different mechanisms that cause the thing inside to warm up or cool down and (2) identify patterns in structural features that seem to be important for slowing or stopping this temperature change" (Teacher Edition, page 57). This is then applied to student models in their progress trackers.
    - Students are given multiple opportunities to revise their thinking and models using the progress tracker in student notebooks. For example, in Lesson 3, students "update their

Progress Tracker with words and pictures that indicate what they have learned so far about the lesson question" (Teacher Edition, page 85).
    - Students draw in their notebook what they think particles are doing in cold water and then compare their models with a partner. The teacher then facilitates a class discussion to generate and share ideas of how the class will "represent greater and lesser particle movement in a substance that they think is consistent with the evidence they have collected" (Teacher Edition, page 205).
- Teachers are provided support on engaging students in using the CCC Energy and Matter at the across Lessons 4 through 6 in the "Supporting Students in Developing and Using Energy and Matter" callout on page 119 of the Teacher Edition. On page 138, more support is given to teachers on how to use the marbles to "track matter flow into or out of the cup system." They are guided to support students in using the "CCC as a lens to help students focus on making connections between the cups with and without lids."
- In the summative assessment, students are to model "what happens when ice comes into contact with the skin" and "account for particles of the ice pack and particles for the skin, how the particles are moving in each system based on their temperatures." "This assessment leverages the following model ideas from Lessons 7 through 14" (Teacher Edition, page 265).

Suggestions for Improvement

Consider providing clear guidance to teachers on how to adjust scaffolding over time to support the development of student competency in each of the dimensions. Although evidence of scaffolds was found to help students engage in the practices or use the CCCs, the reviewers did not find the scaffolds to be adequately adjusted over the course of the unit to build towards proficiency of the targeted 6-8 grade band elements.

Overall Category II Score (0, 1, 2, 3): 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

Score: 3

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*

III.A. Monitoring 3D student performances: Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

Rating for Criterion III.A. Monitoring 3D Student Performances: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena and/or design solutions. Tasks are driven by phenomena or problem-based scenarios that are able to elicit rich student performances. The majority of scenarios are based on specific, real-world, puzzling events or instances, and require grade-appropriate three-dimensional performances to address.

In each lesson, students develop artifacts that use all three dimensions in service of making sense of phenomena or figuring out design solutions using multiple modalities. Assessment tasks include pictures, models, graphs, data tables, and text as summarized in their Assessment Guidance charts on pages 26–40 of the Teacher Edition.

Some other examples of varied opportunities provided for students to make their thinking visible and demonstrate their understanding and ability to use grade-appropriate elements of each dimension in service of sense making include:

- The formative assessment used at the end of Lesson 6 uses a similar phenomenon to the cup system being studied but with different lid designs. This assessment requires students to explain and demonstrate their understanding of some elements from DCI PS1.A Structure and Properties of Matter while engaging in SEPs Developing and Using Models and Analyzing and Interpreting Data and using the implied concepts of CCCs Patterns and Structure and Function.
- The formative assessment used at the end of Lesson 14 uses a different but related phenomenon of an ice pack cooling skin for students to explain and demonstrate their understanding of thermal energy transfer. This assessment requires students to apply their understanding of some elements from DCIs PS1.A, PS3.A, and PS3.B while engaging in SEPs Engaging in Argument from Evidence and Developing and Using Models and using the concept of the CCCs Systems and System Models and Cause and Effect.

- The formative assessment used in lesson set 3 requires students to design, build and test a cup that minimizes thermal energy transfer. This assessment requires students to explain and demonstrate their understanding of some elements from DCIs PS1.A, PS3.A, and PS3.B while engaging in SEPs Constructing Explanations and Designing Solutions and Using Models and using the concepts of the CCCs Systems and System Models and Structure and Function.
- The summative "Disaster Blanket" assessment used at the end of the unit requires students to figure out which blanket is the best to protect humans from losing their body temperature in emergencies. This assessment requires students to apply their understanding on DCI PS3 while engaging in SEP Engaging in Argument from Evidence and using the concepts of the CCCs Structure and Function and Cause and Effect.

Suggestions for Improvement

N/A

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 frequent and varied support for formative assessment processes and guidance is provided.

The materials include many regular and varied opportunities for formative assessment that are called out by the developer. These opportunities are sometimes accompanied with guidance for the key ideas of what to look for in student products. However, clear guidance is not provided for all formative assessment opportunities related to how to interpret a range of student responses and change instruction based on varied student responses.

Formative assessment opportunities are built directly into the instructional sequences are tied to all three dimensions and connected to meaningful learning goals:

- Page 30 of the Teacher Edition provides strategies for dealing with students who make alternate claims during a Scientist Circle activity. They are advised "if students continue to struggle with one or the other of these investigations, point them to their observations during related experiences in which water droplets formed on a surface where there was no water to begin with (e.g., dew forming on grass in the morning, condensation on windows where it was cold inside and warm outside).

- The "Assessment Opportunity" callout on page 69 of the Teacher Edition suggests to use the time while students are collecting data during their Lesson 2 investigation to "circulate among each group" and use the questions provided to listen for students' ideas about "how the changed part of the system affects the mechanism the students believe is causing the drink to warm up" and "whether they controlled the variables they needed to control and how close their group is to manipulating only 1 variable". This formatively assesses student ability to engage in the SEP Planning and Carrying Out Investigations as well as the CCC Structures and Functions of the cup system. An alternate activity is provided on page 70 prompting students to do a gallery walk of the other groups' investigation setups. This activity is implicitly connected to the assessment opportunities described to help students build capacity with this SEP.
- The "Assessment Opportunity" callout on page 113 of the Teacher Edition suggests to "look for one or more key science ideas from the Progress Tracker in students' responses to the handout's question 1 related to particles of matter." No guidance is provided about how to interpret a range of student responses and change instruction based on varied student responses.
- The "Assessment Opportunity" callout on page 126 of the Teacher Edition provides patterns that teachers might see in student responses for the "Cold Lemonade on a Hot Day" assessment. Suggested activities are provided if students lack proficiency with a dimension.
- The "Assessment Opportunity" callout on page 159 of the Teacher Edition suggests using student models and claims supported with evidence to assess student understanding of light and heat in the cup system and how this information "should guide your instructional decisions in the next few lessons". No guidance is provided about how to interpret a range of student responses and change instruction based on varied student responses.
- The "Assessment Opportunity" callout on page 188 of the Teacher Edition prompts teachers to listen to student responses in order to assess if students are able to identify "important controls" and to "make certain they (the procedures) are detailed to conduct a fair test" (Teacher Edition, page 188). Challenge questions are provided if students do not provide accurate responses.
- The "Assessment Opportunity" callout on page 217 of the Teacher Edition suggests using students' "individual explanations to see if and how students are connecting ideas about kinetic energy and particles moving faster in hot water" to their experiences in Lessons 10 and 11 (Teacher Edition, page 217). The "Attending to Equity" callout provides alternate activities to build student capacity with this DCI, however clear guidance is not provided on how this connects to varied student responses.
- The "Assessment Opportunity" callout on page 317 of the Teacher Edition suggests "collecting design packets and examine their ideas" where students wrote individual explanations to justify their 3rd design and provide feedback. Clear guidance is provided on how students should use this feedback "as they propose a new design in Part 8."

Suggestions for Improvement

Consider providing clear guidance for how to interpret a range of possible student responses and how teachers might change instruction based on varied responses. In addition, in order to receive an extensive rating, formative assessments need to attend to issues of student equity and access in some ways by including culturally and linguistically responsive strategies to help interpret and respond to student thinking toward the learning targets. These might include providing multiple ways for students to demonstrate their thinking and some supports for interpreting student responses that attend to linguistic and cultural diversity. Formative assessment processes need to also routinely attend to multiple aspects of student equity including opportunities to leverage student diversity and experiences. This might include formative assessment processes that specifically attend to students' agency and identity as scientists, providing support for modifying instructional activities to be more culturally responsive in addition to supporting student thinking toward learning goals.

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 instructional materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because clear guidance is provided for teachers to interpret student progress.

Lesson Level Performance Expectation (LLPE) assessment targets are clearly provided for each lesson and "Assessment Opportunity" callouts are provided to guide teachers in where to look for evidence of the LLPEs. Rubrics are provided for two of the formative assessments with exemplar student responses included in red found at the end of Lessons 6 and 14. All major formative assessment opportunities include some degree of scoring guidance but lack guidance to support interpreting student progress across all three dimensions. Evidence of this can be found on:

- Page 25 of the Teacher Edition explains the lesson-level performance expectations (LLPE) and states that "assessing every LLPE listed can be logistically difficult. Strategically picking which LLPEs to assess and how to provide timely and informative feedback to students on their progress toward meeting these is left to the teacher's discretion. In the table that follows on pages 26 through 40, detailed explanations providing assessment guidance for each LLPE are provided to support the teacher.
- Scoring guidance is provided in red for the formative assessment "Cold Lemonade on a Hot Day" at the end of Lesson 5 (Teacher Edition, page 129). Suggestions are provided for additional lessons if there are patterns of students who are not demonstrating proficiency with the DCI and CCC.
- A scoring rubric is provided for the Lesson 6 summative assessment assessing SEP Developing and Using Models with emphasis on the CCCs Patterns, Structure and Function, and Cause and Effect in relation to the DCI PS3.B Energy Transfer (Teacher Edition, page 149). A column is also provided on the rubric for teachers to provide feedback.

- Suggested responses are provided for the formative assessment at the end of Lesson 14 on page 277 and 279 of the Teacher Edition. It is suggested that the red indicates “the important ideas to look for in student responses” “but does not indicate a preferred scoring scheme.” A rubric is also provided that includes elements of the SEP Modeling and CCC Cause and Effect and System and System Models in relation to the DCI PS3.B Energy Transfer.
- Suggested responses are provided for the summative assessment at the end of Lesson 18 on page 332 of the Teacher Edition. In the “Assessment Opportunity” callout on page 327, it states that scoring guides are meant to highlight important ideas students should be including in their responses.”

Suggestions for Improvement

In order to receive an extensive rating, consider providing a range of student responses and interpretation guidance to support interpreting student progress across all three dimensions. Also consider providing teachers and students guidance in how to address gaps and misconceptions through future instructional experiences and other assessment opportunities.

III.D. Unbiased tasks/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: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because assessment tasks use appropriate text, do not assume all students know culturally-specific knowledge, and use a variety of modalities to collect information from students.

A variety of assessment tasks using multiple modalities are used to assess student proficiency. The vocabulary and text are grade-level appropriate and often supported by visual representations such as illustrations. The scenarios are culturally neutral and connections to real life have been made for providing potential scaffolds to make sure that students have the background they need to be successful with the task. Task items also provide a variety of ways for students to convey their answers including text, drawing, and talking about their learning.

The Teacher Handbook provides evidence of how the OpenSciEd Units address this criterion in:

- In the first full paragraph on page 13 of the Teacher Handbook, it states that it is “important that each student tries individually to make sense of the phenomenon and then go public with his or her ideas. Diversity in our sensemaking ideas is very productive!”

- The second bullet point on page 41 of the Teacher Handbook explains how "opportunities to assess student thinking are embedded throughout the units" in order to "enable teachers to observe students' authentic reasoning and scientific ideas. Students can demonstrate an understanding of concepts and ability to employ science and engineering practices through a variety of performances that do not privilege particular cultural or language practices."

Evidence can also be found within the lessons including:

- Reading articles provided in Lesson 15 are varied, of appropriate length, and have been selected to connect with students' lives including "How Light Warms Matter", "How Foam and Coffee Sleeves Work", and How Double Walls Work" (Teacher Edition, page 290).
- Students are not expected to use vocabulary terms within their assessments until they have experiences with the concept. For example, in the "Attending to Equity" callout on page 241 of the Teacher Edition describes how the vocabulary term "kinetic energy" is introduced after the students "have developed an understanding particles can move more and faster or less and slower".
- The Student Handbook uses icons to focus students on the task to be accomplished instead of relying solely on text. There is an icon for "On Your Own", "With Your Group", "In Your Notebook", as well as others.

Suggestions for Improvement

In order to receive an extensive rating, consider structuring opportunities for variety in the modalities expected for student responses, such as talking about their learning, creating visual representations, or writing short or more complex answers. Also consider including at least one significant task that provides students with a choice of responses across multiple modalities.

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: Extensive

(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 because a coordinated system of assessments is used that connects to the three-dimensional learning goals of each lesson.

The instructional materials consistently provide three-dimensional designed assessments that require students to apply appropriate elements of the three dimensions to make sense of the phenomenon and solve problems. Assessments are multidimensional and match the LLPE presented at the start of each lesson as well as in the "Assessment System Overview" on pages 22–40 of the Teacher Edition.

Evidence of the types of assessments found in the coherent assessment system include:

- Pre-assessment: Page 17 of Teacher Edition states that one purpose of the anchoring phenomenon is to "probe students' initial ideas of what it means for something to warm up and mechanisms for how this happens in the cup system context." On page 52 of the Teacher Edition, an assessment opportunity callout provides things to "look for" in students' initial models for a pre-assessment.
- Pre-assessment: Teaches are prompted on page 105 of the Teacher Edition to use the predictive models students create of the water evaporating from a cup to pre-assess their understanding of particulate models of matter.
- Self-assessment: Page 48 of the Teacher Handbook provides a rubric for students to evaluate their contribution of ideas, active listening, ability to provide and receive critique, and facilitate others in sharing their ideas when engaging in classroom discourse.
- Self-assessment: Page 51 of the Teacher Handbook provides a rubric for students to evaluate their ability to give and receive peer feedback.
- Formative Assessment: The "Cold Lemonade on a Hot Day" assessment is used at the end of Lesson 5 to assess student understanding of where water comes from that forms condensation on a cold glass (Teacher Edition, pages 127–129).
- Formative Assessment: Student models in notebooks may be used for formative assessment of student understanding related to light and heat in relation to the cup system" (Teacher Edition, page 159).
- Formative Assessment: Students complete the "Explaining Different Cup Designs" assessment at the end of Lesson 6 to assess student understanding of the CCC Structures and Functions of the Cup Systems, DCI PS3.B Conservation of Energy and Energy Transfer, SEP Developing and Using Models of particle representations of liquids and gases (Teacher Edition, page 142).
- Summative Assessment: Students complete the end of unit summative assessment with a transfer task that requires them to make sense of a related but different phenomenon of how emergency blankets work using the concepts of thermal energy transfer.

<u>Suggestions for Improvement</u>
N/A

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

<u>Rating for Criterion III.F. Opportunity to learn:</u> Adequate
(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts because for key, claimed learning in the unit, there are multiple linked student performances that provide students with several opportunities to demonstrate understanding.

Although there are multiple opportunities for students to demonstrate understanding and receive feedback, only a few opportunities are provided for students to utilize a multimodal feedback loop across a series of student performances to demonstrate new thinking based on peer and teacher feedback and/or personal reflection. Examples can be found when:

- Students provide feedback to one another and offer additional suggestions for improving cup designs in Lesson 16 and then revise their designs in Lesson 17.
- Students use the progress tracker for individual reflection of their learning throughout the unit and models are continuously revised using new learning when they update the progress tracker.
- Students are provided feedback on their investigation plans in Lesson 4 to make adjustments before starting the lab on day 2 (Teacher Edition, page 101). However, time is not provided on day 2 for adjustments to be addressed.
- Feedback is provided using the Lesson 6 Assessment Rubric. However, time is not provided for students to revise their thinking.
- Feedback is provided by the teacher on student claims and models in the assessment opportunity in Lesson 7 (Teacher Edition, page 159). However, time is not provided for students to revise their thinking.
- Feedback is provided using the Lesson 14 Assessment Rubric. However, time is not provided for students to revise their thinking.
- Students engage in a quick write to reflect on their experiences throughout the unit and share their reflections in a whole group discussion (Teacher Edition, page 329).

Suggestions for Improvement

Consider including more multi-modal feedback loops where students are provided a series of opportunities to demonstrate new thinking based on peer and teacher feedback and personal reflection.

Overall Category III Score (0, 1, 2, 3): 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

How Can Containers Keep Stuff From Warming Up or Cooling Down?
EQuIP Rubric for Science Evaluation

Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): 2
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 3
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 3
Total Score: 8
Overall Score (E, E/I, R, N): ***Example of high quality NGSS design***

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)
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 (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)*