# Bath Bombs: How Can We Make Something New That Was Not There Before?

# EQuIP Rubric for Science Evaluation

**Developer/Curriculum:** OpenSciEd
**Unit Name:** Bath Bombs: How Can We Make Something New That Was Not There Before?
**Grade:** 7, Middle School
**Date of Review:** July 2020
**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 NextGenScience 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** | Extensive |
| **C. Integrating the Three Dimensions** | Extensive | **C. Building Progressions** | Adequate | **C. Scoring Guidance** | Adequate |
| **D. Unit Coherence** | Extensive | **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** | Extensive | **F. Opportunity to Learn** | Extensive |
| | | **G. Scaffolded Differentiation Over Time** | Extensive | | |

## Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. The unit is strong in several areas, including having a robust phenomenon to engage students in the three dimensions. The unit storyline demonstrates coherence and shows how learning takes place over time through scaffolding. The Teacher Edition includes scaffolding support for implementing use of the anchoring phenomenon, routines of the unit, three-dimensional lesson-level performance expectations that are aligned to a coherent system of assessment, setting class norms to enforce equitable science discourse, learning progression of the focal Science and Engineering Practices (SEPs) and Crosscutting Concepts (CCCs) explained in the Teacher Background Knowledge, and clear guidance on how to develop argumentation and explanation skills. The visual supports for teachers, including student facing videos, pictures of the lab set up, examples of student work, and detailed slide notes are especially helpful.

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

Although students are using CCCs to make sense of the phenomenon, consider providing the same level of scaffold for students to develop the CCCs claimed in this unit as the SEPs and Disciplinary Core Ideas (DCIs). Also, to truly make the unit integrated, students should be using the life science DCIs to help them figure out the anchoring phenomenon or consider using CCCs to intentionally and explicitly make connections across multiple science disciplines.

Note that in the feedback below, black text is used for either neutral comments or evidence that 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.<br>• Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.<br>• The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.<br>• 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

The reviewers found extensive evidence that learning is driven by students making sense of phenomena. The unit is designed to support students in figuring out an intriguing phenomenon of what happens to a solid bath bomb when it reacts with water and where the gas bubbles come from. In order to motivate students to figure out the anchoring and lesson-level phenomena, students have many opportunities to ask questions and connect to their prior experiences involving chemical reactions. Students regularly return to the unit phenomenon to add layers of explanation based on the evidence they gather and revise their models. Throughout the unit, lessons are driven by new wonder and questions developed from previous lessons that drive students learning into the next lesson.

The following examples are evidence for this criterion:

- Lesson 1: Students "observe different kinds of bath bombs and what they do when added to water" (Teacher Edition, page 25). The phenomenon is relevant and engaging because students share their experience with bath bombs at home and also directly engage in the phenomenon by observing a bath bomb before, during, and after it is added to the water while in class. Students create an “I Wonder/I Notice” chart and use their senses, such as sound and odor, to record their observations.

- Lesson 2: The lesson is focused on supporting students to better make sense of the phenomenon. Students “investigate bath bombs and take careful measurements to determine where the gas bubbles” come from (Teacher Edition, page 51). The class engages in a “Building Understandings Discussion” to help them make sense of the data, and later use the evidence to build a well-supported argument.
- Lesson 5: Students try to figure out what gas could be coming from the bath bomb reaction with water. Students design an investigation to experiment with different ingredients in a bath bomb and analyze properties of different pure substances. Using patterns from the data, students eliminate the gases that are not possible candidates. Throughout this process students act as detectives and engage in competing claims to help explain the phenomenon.
- Lesson level phenomena are used to help students build understanding and figure out the anchoring phenomenon. For example, in Lesson 8, students read about Dalton and other scientists heating water and putting electricity through water, finding both caused bubbles to form. Students replicate the experiments and try to identify what the gas is made of in Lessons 9 and 10:
    - Lesson 9: Students observe the gas produced from heating water and test its flammability. Students also measure the density of the clear liquid collected from the cooling gas to identify the substance. This lesson helps students build understanding toward the anchoring phenomenon as students continue to figure out how to identify unknown substances from a reaction.
    - Lesson 10: Students add energy to water with electricity and argue from evidence whether the bubbles are made of the same particles produced from heating the water. Students use this activity to help them understand where the matter that makes up the gas particles come from.
- Students regularly return to the phenomenon to add layers of explanation based on new learning:
    - Lesson 3: Students “analyze ingredient list for a store-bought bath bomb and recipes for homemade bath bombs and make observations on each of the main ingredients” in order to determine what causes the gas bubbles to appear (Teacher Edition, page 77).
    - Lesson 4: Students try to answer the question, “What is in a bath bomb that is producing the gas?” (Teacher Edition, page 103). Students figure out that mixing citric acid, baking soda, and water cause gas bubbles to form, and the gas bubbles are different from the original substances. They include this piece of evidence in the progress tracker to help them explain the anchoring phenomenon.
    - Lesson 5: Students argue from evidence what gas(es) could be produced by a bath bomb reaction. The class tests “the flammability of air from the room, gas from the bath bomb, and helium gas” (Teacher Edition, page 117). They argue from evidence that the gas from the bath bomb could be nitrogen, argon, or carbon dioxide.

- Lesson 7: Students take stock of what they have learned from Lessons 1–5 and revise their initial consensus model to better represent the particles that make up different substances.
- Lesson 8: Students examine the bath bomb chemical reaction at the particle level (citric acid + baking soda + water → a new substance in the gas bubbles) and figure out that "the particles of the citric acid/baking soda/water might break apart and make a gas" (Teacher Edition, page 171).
- Lesson 11: Students construct models to predict and explain what gas is produced in the bath bomb reaction. Students figure out that "the particles that make up old substances can be broken apart and the atoms that make them up can be rearranged to form new molecules to make new substances" (Teacher Edition, page 8).
- Lesson 12: Students explain and revise their consensus model "with the molecules of the reactants and the gas produced from the bath bomb" (Teacher Edition, page 227). Students develop a model to represent what is happening in this reaction at the particle level.

- Students' questions are used to motivate the learning:
  - The Driving Question Board (DQB) provides a structured support for teachers to draw out these connections from students and use these connections to motivate student learning. The teacher is guided to "Tell students that we are going to capture all of our questions today. The purpose of this work is to use all of our individual questions to determine what it is we want to figure out as a class. To do that, we need to prepare to get all of our questions shared and represented on a single board, which will be called our Driving Question Board" (Teacher Edition, page 44).
  - Students take stock of questions on the DQB (Lesson 1, Three, 6, 12, 13) and add new questions by using exit tickets. For example, in Lesson 3, students write down new questions they have based on the investigation on the exit ticket.
  - Additional Guidance sections include suggestions and connections for teachers. For example, in Lesson 1, it says to "Keep in mind that this list is simply a set of 'initial draft ideas.' Given more time and additional learning experiences, you will see students' ideas shift. They will think of new things to investigate that will become targeted at answering the most pressing and relevant questions emerging from their work at that point in the unit" (Teacher Edition, page 48).
  - Lesson 8: Students "develop alternate models for how new particles might be made from old particles" and list questions "about how we could figure out what happens when new substances are made from old substances" like a gas being released when the bath bomb and water combine (Teacher Edition, page 167). As students ask more questions, they start to explore the bath bomb reaction at the molecular level.
  - Learning Plans include Navigation sections with suggestions to begin lessons by reviewing what was learned in previous lessons. For example, in Lesson 7, "Begin by saying, Let's recap and take stock of what we have figured out and what

questions we still have about our bath bombs in relation to our Driving Question: How can we make something new that was not there before?" The Supporting Students section informs teachers that "Having students take stock of the big ideas that they have learned during their previous investigations helps support students in taking stock of which questions students have fully answered, and what questions they have still not answered because they do not have evidence to fully answer them. Engaging in this practice will help students navigate from where they have been and what they need to do next to make progress on the unanswered questions" (Teacher Edition, page 153).

- Lesson 12: Students explain and revise their consensus model "with the molecules of the reactants and the gas produced from the bath bomb" (Teacher Edition, page 227).

Suggestions for Improvement

N/A

**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

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because Crosscutting Concepts, Science and Engineering Practices, and Disciplinary Core Ideas are all intentionally utilized and developed at a grade-appropriate level in service of making sense of phenomena.

***Science and Engineering Practices (SEPs): Extensive***

The reviewers found extensive evidence that students have the opportunity to use or develop the SEPs in this unit because students are provided with many opportunities to both use and develop several grade-appropriate SEP elements throughout the lessons.

The following examples are strong evidence of where students are using and developing claimed SEPs throughout the unit. There are two claimed elements of the SEPs, **Obtaining, Evaluating, and Communicating Information** and **Using Mathematics and Computational Thinking,** that are not included below because they were only developed or used by students once in the unit. Therefore, the reviewers did not find strong evidence that students were able to fully engage with those SEPs.

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- **Asking Questions and Defining Problems**
  - *Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information* (students use this element).
    - Lesson 1: Students observe what happens to a bath bomb when it is placed in a bowl of water. Students record their thoughts on an "I Notice/I Wonder" chart and develop an initial model to explain what they noticed from the reaction. Students are instructed to "record any questions that come to mind as you are developing your model" (Student Guide, page 4). However, explicit guidance is not provided for students to ask questions that will allow them to seek more information about the reasons behind the bath bomb reaction or to clarify their models.
    - Lesson 3: Students examine the main ingredients found in a bath bomb and investigate their properties, such as solubility in water. Students find out that none of the substances made bubbles when added to water. In response to this, students are prompted to pose further questions and investigations which could help them explain their results. The teacher asks the following questions on an exit slip: "What else should we investigate about these substances or try to do using these substances?" and "What is one new question you have based on the investigation we did today?" (Teacher Edition, page 95).
  - *Ask questions that can be investigated within the scope of the classroom, ~~outdoor environment, and museums and other facilities with available resources and when appropriate frame a hypothesis based on observations and scientific principles~~* (students use parts of this element).
    - Lesson 1: After students generate questions based on their observation of the anchoring phenomenon, they evaluate the questions and brainstorm initial ideas for future investigations on the "Ideas for Investigations" poster. The teacher "encourages students to think about their questions and see if they have an idea to investigate a specific question or group of questions" and "think about things that could be investigated to help address some areas of disagreement we have as a class" (Teacher Edition, page 47).

- **Developing and Using Models**
  - *Develop and/or use a model to predict and/or describe phenomena* (students develop this element).
    - Lesson 1: Students are provided the following guidance when creating their initial model: "Your model should include pictures, symbols, and words to help you represent and explain what you think" (Student Edition, page 4).
    - Lesson 1: Students develop an initial model to explain what is happening when a bath bomb is added to water and explain why gas bubbles appear. After students develop the model individually, they then work in pairs to compare models and "as the group notes similarities between the diagrams, they can make a small check mark on their diagram noting that it is similar to a diagram by another member in their group. If they have a different thing, or the group is confused

about part of the system, they can mark those parts of the diagram with a question mark" (Teacher Edition, pages 37–38).

- Lesson 1: Students develop a macroscopic and microscopic model of the bath bomb before adding it to the water, a couple seconds after adding it to the water, and when the gas bubbles appear (7.1 Lesson 1 Handout Initial Model-based Explanation). This model template provides a good scaffold for the students to know what they need to include in the model to observe the phenomenon. The zoom in bubbles elicit students' ideas on the unobservable mechanisms (Teacher Edition, page 29). Additional guidance is provided to help students understand the purpose of a scientific model by telling students that "Scientific models are dynamic and change as new information is learned, and models need to be 'applied' to explain phenomena or design solutions to be considered useful" (Teacher Edition, page 42).
- Lesson 7: Students revise their class consensus model by adding evidence they have collected from Lessons 1–6. "Cue students to use their Progress Trackers and other resources in their notebooks to support what we figured out in each lesson" (Teacher Edition, page 154). Students revise their models and the teacher is prompted to "circulate among [students] prompting them to defend their model ideas (or part of their model) using evidence collected during investigations in Lessons 1 through 5" (Teacher Edition, page 165).
- Lesson 8: The class develops a particle-based model to represent what they think is happening to the substances in the bath bomb that create the gas. This model includes all initial thinking and predictions of how the particles may come apart, join together, and come apart and rejoin together in different ways.
- Over the course of the unit, students develop many models, but two of these models are revisited and refined over and over again (the initial consensus model and a particle-based model that is first introduced mid-unit). One nature of science component of this practice is that scientists revise their prior models to help them make sense of a phenomenon as they collect new evidence. This nature of science connection is made explicit in the readings about Dalton's work in Lesson 8 and Lesson 10.

- **Planning and Carrying Out Investigations**
  - *Conduct an investigation and/or evaluate and/or revise the experimental design to produce data to serve as the basis for evidence that meets the goals* (students use this element).
    - Lesson 1: Students have a chance to investigate and look at four homemade bath bombs made of different recipes. Students brainstorm how they want to work with the materials (paper plates, toothpicks, pipette, clear plastic cups, water, paper towels) and decide what data they want to collect. Students create a data table to record their results from the investigations (Student Guide, pages 3–4).
    - Lesson 4: Students conduct an investigation to find out "what is in a bath bomb that is producing the gas" (Teacher Edition, page 103). They experiment with

different combinations of ingredients found in bath bombs and find out that the only combination that can produce gas bubbles is citric acid, baking soda, and water.

- *Plan an investigation individually and collaboratively, and in the design: ~~identify independent and dependent variables and controls~~, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim* (students develop this element).
  - Lesson 2: The class tries to answer the question, "Where does the gas produced by the bath bomb come from?" Students work in groups to determine whether the gas from a bath bomb is new matter or not. During these discussions, the teacher "pays attention to which of [the] students are able to contribute meaningfully to identify the data, tools, and measurements needed to answer the lesson question" (Teacher Edition, page 59).
  - Lesson 3: Students try to figure out how gas is produced from a bath bomb reaction by testing how each ingredient reacts with water. As students share their ideas on the procedure, the teacher asks, "why is it important to test each one individually rather than just putting a bunch of ingredients at the same time?" "Asking students questions such as this will help students think about how to limit variables in their investigation in order to obtain more reliable data that will support them in their development of understanding over time as they engage in the practice of planning an investigation" (Teacher Edition, page 87). However, the questions the teacher asks are more aligned to the grade 3–5 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,* because students are guided to think about the importance of having controlled variables in an investigation, instead of identifying the independent, dependent, and control variables.
  - Lesson 3: Students brainstorm, "What mass measurements should we take, and when should we take them...What materials do you want so you can obtain the mass for everything used in the system, and why is that important? " (Lesson 3, Slide I). The materials solicit ideas for data to collect: "What types of data in this investigation are important for us to keep track of? What are some different ways we could keep track of this data? What kinds of things have we kept track of in our other investigations? Are those also important to keep track of here?" "Asking students questions such as these will support them in figuring out what evidence they need to collect, and how to accurately collect it when setting up their investigation. This will help students in their development of an understanding of this practice over time as they engage in planning an investigation" (Teacher Edition, page 88).

- **Analyzing and Interpreting Data**
  - *Analyze and interpret data to provide evidence for phenomena* (students develop this element).

    - Lesson 2: Guidance is provided to teachers to lead students through the "Building Understanding Discussion" around analyzing the data they have collected. "Make a record of the discussion. Guide the discussion using questions such as the ones that follow, and use a new piece of chart paper to track the discussion of which data can be used as evidence to support each claim. Begin by setting up a chart to record our observations from this investigation, such as the one shown here" (Teacher Edition, page 68).
    - Lesson 3: After observing ingredients of bath bombs and recording their observations in a data table, students answer the following questions: "What are some patterns you noticed in your data? Did we find any evidence that would help us figure out why the bath bomb produced gas bubbles?" (Student Edition, page 11).
    - Lesson 4: Students test to see if bubbles form when the various combinations of substances found in a bath bomb are combined in water. Students collect data on a class-wide data table and look for patterns to "develop an argument that citric acid and baking soda produce gas when combined with water and that the gas must be a new substance because it has different properties than the substances we started with" (Teacher Edition, page 112).
  - *Construct, analyze, and/or interpret graphical displays of data and/or large data sets to identify linear and nonlinear relationships* (students develop this element).
    - Lesson 9: Students collect and record volume versus mass and density data for three substances: water, glycerin, and rubbing alcohol. They look for and record patterns in the data. "Ask students to share out some of the patterns they noticed. Start with patterns within the graph and table for one substance and then shift to having students compare the graphs and tables of different substances." Teachers are told that the goal for discussion is to make connections to 7th grade mathematics. Students "identify the constant of proportionality (the unit rate) from tables, graphs, or an expression and identify this unit rate (mass divided by volume) as the density of that substance" (Teacher Edition, pages 187–188).

- **Engaging in Argument from Evidence**
  - *Construct, use, and/or present an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation of a model for a phenomenon ~~or a solution to a problem~~* (students develop this element).
    - Lesson 2: Students engage in a discussion about how the evidence they have collected is used to support or refute a claim. Students underline evidence and highlight Key Model Ideas to scaffold and help students develop the practice of argumentation. The teacher displays a poster and also Slide V to show elements of a strong and convincing argument: a claim that answers a question about a phenomenon, supports claim with evidence, and uses reasoning to explain what the data means using the Key Model Ideas. (Teacher Edition, page 74)

        - Lesson 5: Students write an argument to answer the question, "What gas(es) could be produced by a bath bomb?" The teacher reminds the class that the ideas on the Anchor Chart can be used to build a strong argument. The Anchor Chart, "Arguing for (or against) a Claim," contains "1) Make a claim that answers a question about a phenomenon; 2) Support your claim with both a) evidence: referencing data that support (or refute) the claim; b) reasoning: explaining what these data mean and when applicable using the key mode ideas" (Teacher Edition, page 138). Students are guided to "Use evidence from Some Common Gases and your investigations on density and flammability to support your claim" (Handout Discussion Protocol: Flammability and Density).

- **Construction Explanations and Designing Solutions**
    - *Apply scientific reasoning to show why the data or evidence is adequate for the explanation or conclusion* (students develop this element).
        - Lesson 2: Students carry out class investigations and organize data tables that can be used to collect evidence that gas is (or is not) trapped inside a bath bomb. "Let's see if we can use any of this data as evidence in support of or against our claim that the gas is trapped inside the bath bomb. Add this question to the title of your chart: Does this data provide evidence for or against the claim? Then, as you point to each row of data, ask, is this evidence in support of or against this claim?" (Teacher Edition, page 62).
        - Lesson 9: Students construct an explanation to support the claim that "the gas inside the bubbles is made of water particles." Students decide what evidence and Key Model Ideas help support their claim.
    - *Construct a scientific explanation based on valid and reliable evidence obtained from sources (including the students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future* (students develop this element).
        - Lesson 10: Students observe flammability tests on collected gasses and use their data to compare gasses and determine if they are the same or different. They then construct an explanation to answer the question: "When energy from a battery was added to water, were the gases produced by this made of the same particles as were produced from heating the water?" They use data from the investigations, the Some Common Gases handout, and Key Model Ideas to help them construct an explanation (Teacher Edition, page 207).
    - *Apply scientific ideas, principles, and/or evidence to construct, revise and/or use an explanation for real world phenomena, examples, or events* (students develop this element).
        - Lesson 11: Students construct a revised explanation individually to explain why the gas that was produced could only be one of the substances they circled and not the other two.

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

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The reviewers found extensive evidence that students have the opportunity to use or develop the DCIs in this unit because there are sufficient DCI elements for the length of the materials and the elements are clearly used by students to make sense of phenomena.

The following examples are strong evidence of where students are developing DCIs:

- **PS1.A: Structure and Properties of Matter**
  - *Substances are made from different types of atoms, which combine with one another in various ways.*
    - Lesson 7: Students organize the information they have learned in previous lessons to revise their original model. In the process, students prepare a table which describes the inputs and outputs of the reaction to begin describing how substances react.
    - Lesson 8: Students use manipulatives to explore how different substances can break apart or come together to form new substances.
    - Lesson 11: Students read an article about Dalton's Investigations and collect information about how atoms combine to make new substances.
    - Lesson 12: Students look at molecular models on the Handout: Comparing Molecular Rations in a Chemical Reaction and "account for all the atoms in the reactants also being in the products (Teacher Edition, page 239).
  - *Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.*
    - Lesson 3: Properties of the different ingredients of a bath bomb are investigated, such as solubility and states of matter at room temperature.
    - Lesson 4: Students gather in Scientists Circle and have a consensus discussion about what they've figured out so far. One of the Key Model Ideas students identify from Lesson 3 is that "properties don't change for a substance" (Teacher Edition, page 105).
    - Lesson 5: Students look at properties of gases and determine which properties would be good to use to find out what gas is coming from the bath bomb. Students then investigate these properties to determine what gases may be produced by the bath bomb.
    - Lesson 9: Students graph volume versus mass of water. The teacher is guided to "ask students what they notice about all the values in this column in each table. They should say values are very similar to each other" (Teacher Edition, page 189).
    - Lesson 13: Students carry out an "Odor Lab" where they look at molecular models and relate them to the substance producing particular odors (Lesson 13 Handout Odor Lab).

- **PS1.B: Chemical Reactions**

- *Substances react chemically in characteristic ways. In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.*
  - Lesson 10: Students add energy to water with electricity and test the flammability of the gases produced from the water. Students figure out that the two gases are new substances that have different properties from the water, and they come from matter that is made up from some of the original water particles.
  - Lesson 11: Students use manipulatives to explore how different substances can break apart or come together to form new substances. Students learn to use chemical formula notation to help them represent different molecules.
- *The total number of each type of atom is conserved, and thus the mass does not change.*
  - Lesson 12: Students use molecular models to represent the chemical reaction that occur. "When we start to consider how many molecules of reactants and products should be included in a chemical reaction, one of the things we may start to notice is whether all of the reactant molecules would be used up or not. How do we know all the atoms of the molecules of the reactants need to be used up? Students should say because we figured out that atoms don't disappear. We figured this out when we took the mass of the bath bomb before and after adding it to water in a closed system" (Teacher Edition, page 238).
  - Lesson 12: Students examine two models on Handout: Comparing Molecular Ratios in a Chemical Reaction and discuss "Which of these models is a stronger model for supporting an explanation for why the mass of the closed system didn't change during the reaction?" (Teacher Edition, page 239). For students who need support, the teacher "encourages them to count up all the atoms to determine whether the same amount of matter is in the reactants as is in the products in both models" (Teacher Edition, page 239).

- **LS1.D Information Processing**
  - *Each sense receptor responds to different inputs (~~electromagnetic, mechanical,~~ chemical), transmitting them as signals that travel along nerve cells to the brain. ~~The signals are then processed in the brain, resulting in immediate behaviors or memories.~~*
    - Lesson 13: Students engage in a reading which describes how sensory receptors in the nose work. The reading discusses how specific receptors in the nose are able to sense different molecules, which triggers a response. The reading states, "Once the odors make contact with a receptor they stick to it and are 'locked' into the receptors. When this happens these types of receptor neurons relay a signal to the brain through other nerve cells that are part of a structure called the olfactory bulb that is located at the back of the nose. These signals are processed by our brain. Memories of other experiences with similar signals help us categorize and recognize times when we detected the same or very similar odor" (How Do We Detect Odors Reading, page 1).
    - Lesson 13: Students participate in an "Odor Lab" where they relate the structure of molecules to the odor which is produced.

- This DCI is connected to the phenomenon by exploring the chemical property of odor. The teacher is instructed to "Ask a few students to share what they discussed with their partner. They should share that we have odor listed as a property, but it is kind of confusing as a property because we don't all smell things the same way. So we want to investigate odors" (Teacher's Edition, page 251). However, the learning about detection of odors is not done directly in service of making sense of the anchoring phenomenon.

***Crosscutting Concepts (CCCs): Adequate***

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit because there are sufficient CCC elements for the length of the materials and a reasonable match between the CCCs claimed and evidence of CCC development and use. However, elements of the **Scale, Proportion, and Quantity** CCC are either not fully developed in the unit or the author did not claim them even though some lessons support students in developing and using the CCC element.

The following examples are strong evidence of where students are using and developing numerous Crosscutting Concept elements:

- **Patterns**
  - *Macroscopic patterns are related to the nature of microscopic and atomic-level structure* (students develop this element).
    - Students begin the unit by developing an initial model to represent what is happening to the bath bomb when it is added to water and a gas is produced. This initial model includes what students can see and what they think is happening on a smaller scale that they can't see. This model gets revised and refined by students as they collect more evidence. By the end of the unit, students are using this thinking to explain what is happening at a molecular scale that results in the occurrences at the macroscale. Students also need to apply this thinking to explain marble changes in the Taj Mahal at the molecular level.
    - Lesson 1: Students create a model which includes what they believe is occurring at a microscopic level. "Include a zoomed-in view to explain what happened. It should show any changes you think might be happening to matter in the system at a scale smaller than you can see" (Student Edition, page 4).
    - Lesson 11: "Students' engagement in finding and making sense of patterns is generally more complex than their work in prior units. In prior units, students' work of looking for patterns in the relationship between the macroscopic and microscopic properties did dive into the molecular or atomic structure of different substances. In this unit, students will figure this out through doing an electrolysis lab in which they add electrical energy to water (a substance made of one kind of particle) and produce two different substances (oxygen gas and hydrogen gas). This leads students to argue that the particles we have been modeling must be made up of more than one type of particle and they revise their

particle model to include pieces of particles, or atoms" (Teacher Background, page 7).

- *Graphs and charts can be used to identify patterns in data* (students use this element).
  - Lesson 4: Students are asked to analyze their lab data regarding what occurs when substances are mixed. "Ask the whole class to identify patterns in the data. Ask students how we can use this chart to make sure that each combination yielded the same results for both groups that tested them. Students should point out that the results were confirmed by multiple tests" (Teacher Edition, page 108).
  - Lesson 9: Students plot data of mass vs. volume of water and interpret the patterns from the graph. Based on the analysis students figure out that mass and volume are in a directly proportional relationship, and that "the ratio of mass to volume should be constant for a substance measured in the same conditions" (Teacher Edition, page 189).
- *Patterns can be used to identify cause and effect relationships* (students use this element).
  - Lesson 2: Students review the ingredient lists for store bought and homemade bath bombs. They look for patterns in the ingredients and connect to the idea that ingredients might be responsible for the bath bombs bubbling. Teachers "guide students to note patterns in the data, and categorize these using words/phrases that scientists also use to describe similarities and differences around different kinds of characteristics. Have students state the purpose of looking at the ingredients to help them to connect these activities to the original phenomena" (Teacher Edition, page 83).
  - Lesson 14: Students look for patterns in data to "explain which products could be produced" from a chemical reaction between either a) the calcium carbonate in the marble surface of the Taj Mahal and pollutants in the air or b) iron in the rods and clamps of the Taj Mahal and pollutants in acid rain (Teacher Edition, page 263).

- **Energy and Matter**
  - *Matter is conserved because atoms are conserved in physical and chemical processes* (students develop this element).
    - Lesson 1: When conducting the consensus discussion, teacher prompts are provided to assist students in developing this thinking. For example: in the Key Ideas section, the teacher listens for possible areas of disagreement/controversy, such as "was the gas released from pockets in the solid vs. evaporation or boiling vs. a new kind of material that wasn't there before?" (Teacher Edition, page 41).
    - Lesson 2: Students observe an open vs. closed system and figured out that the gas is not made of new matter.
    - Lesson 6: Students analyze data to compare the mass of the system before and after mixing the ingredients. They use this data to help them determine whether a new substance was made.

        - Lesson 10: Students start to think about mass conservation in a system and find out that the mass before adding electrical energy is the same as the mass after the gas is produced.
        - Lesson 12: Students use molecular models to represent the chemical reaction which occurs. Through this process, students figure out that atoms are conserved during chemical processes.

- **Scale, Proportion, and Quantity**
    - Although the author claims that the focal CCCs for this unit include **Scale, Proportion, and Quantity**, the materials do not list the lesson where students are developing their thinking for this CCC as with the other two CCCs (Patterns & Matter). The materials do not provide guidance on how students are explicitly developing **Scale, Proportion, & Quantity** throughout the unit.
    - **Unclaimed element:** *Phenomena that can be observed at one scale may not be observable at another scale.*
        - Although this element is not claimed in the materials and there is no explicit teacher guidance to support students in developing and using this element, there are lessons in the unit that support students in developing and using this element. For example:
            - Lesson 1: Students construct an initial model to show what they think is happening at a scale they can't see by using circles to show zoomed-in views at different points in time. They annotate zoomed-in circles to explain what they think is happening to the matter.
            - Lesson 11: Students learn from the reading, "A summary of some historical investigations and discoveries into the particle nature of matter," that particles are made of smaller parts called atoms. Students then use molecular models to help them predict and explain what gas is produced in the bath bomb reaction.
    - *Scientific relationships can be represented through the use of algebraic expressions and equations* (students develop this element).
        - Lesson 9: Students plot data of mass versus volume of water and interpret the patterns from the graph. Based on the analysis, students figure out that mass and volume are in a directly proportional relationship. Students calculate the density of substances and express density as a unit rate that can be calculated with the expression mass/volume.

<u>Suggestions for Improvement</u>

SEPs:

- Consider providing opportunities for students to select (and name) the practice that they are using and why the practice will help them figure out the phenomena.
- Consider providing opportunities for students to develop and use SEP elements in their entirety. For example, in the **Planning and Carrying Out Investigation** element *Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim,* 7th-grade students should be provided guidance to identify the three types of variables.

DCIs:

- Consider using LS1.D to build context rather than being developed and used by students since there is not a strong connection between the 6–8 element of sense receptors responding to the input of odor.
- Consider using the life science DCIs directly in service of making sense of the anchoring phenomenon or consider using CCCs to intentionally and explicitly make connections across multiple science disciplines.

CCCs:

- Scale, Proportion, and Quantity is listed as a CCC, but the students do not fully engage in this CCC, especially with the element: "*Phenomena that can be observed at one scale may not be observable at another scale.*" There are several missed opportunities where students could be explicitly developing this thinking. For instance, students should know the relative scales of molecules and understand the purpose of visual models. "Scale and proportion are often best understood using models. For example, the relative scales of objects in the solar system or of the components of an atom are difficult to comprehend mathematically (because the numbers involved are either so large or so small), but visual or conceptual models make them much more understandable" (NGSS Appendix G – Crosscutting Concepts, page 6). By calling this out, students can connect this thinking to the Patterns element: "*macroscopic patterns are related to the nature of microscopic and atomic-level structure.*"
- Consider providing opportunities for students to engage with the scales and portion lens of the CCC; during the lessons emphasize where properties of large numbers of molecules are tested and connected to properties of individual molecules (e.g. density, odor, flammability).
- Whenever possible, consider prompting students to see how an explicit understanding or use of the CCC element helps them to explain or understand what they are trying to figure out about the phenomenon. Consider clarifying why the CCCs are necessary or important for understanding and explaining the phenomenon in the unit (and if possible, in lessons) so that teachers and students build an understanding about the utility and purpose of the CCCs in making sense of the phenomena and build proficiency in using them deliberately as sense-making tools.

**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

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena because there are numerous events where all students are expected to figure the cause behind gas production in a bath bomb reaction in a way that requires grade-appropriate elements of all three dimensions and the purposeful integration of the dimensions.

Integration of the three dimensions is apparent throughout the lesson by the inclusion of the three-dimensional learning goals for each lesson. For example:

- In Lesson 7, students are asked to "Develop and revise a model to predict and describe the unseen interactions between particles in a system to show that matter is conserved in a process where the type of particles that make up the starting substances (system inputs) somehow change through their interactions to make different type(s) of particle(s) in the ending substances (system outputs)" (Teacher Edition, page 165).
- In Lesson 13, students "Read scientific texts adapted for classroom use to determine how the molecular structure of different substances (patterns) is related to their odor, how those molecules reach our nose (cause), and how those molecules interact with different sensory receptors there that each cause a different signal to travel through our nerve cells that leads to the perception of different scents (effect)" (Teacher Edition, page 247).

The integration of the three dimensions purposefully helps students figure out the phenomenon. For example:

- Lesson 2: Students plan an investigation to determine the origin of the gas produced from a bath bomb placed in water. During this lesson, students develop the SEP of **Planning and Carrying out Investigations** as well as the CCC of **Energy and Matter** while beginning to build an understanding of an element of DCI **PS1.B**.
- Lesson 3: Students look at the ingredients in bath bombs and collect information about the properties of each ingredient. During this lesson, students develop the SEP of **Analyzing and Interpreting Data** and the CCC of **Energy and Matter** while developing an understanding of an element of DCI **PS1.A**.
- Lesson 6: Students apply Key Model Ideas and patterns of mass and property data to construct three explanations for: a) why the mass of a system decreases when substances are mixed together, b) which substance(s) could or could not be produced in that process, and c) what additional tests could be done on the gas (or other gases) to help identify additional substances that aren't being produced in this process. Students engage in CCCs by explaining what causes the mass of the system to change. Students are demonstrating their understanding that mass is conserved. Students use SEPs by constructing a written argument around "what gases could not have been produced in this process." In their response, students need to include reasoning using Key Model Ideas (DCIs). For example, "The gas that was collected from the elephant's toothpaste

investigation can't be nitrogen, argon, carbon dioxide, neon, helium, air, or carbon monoxide because it put out a flame. We know this based on the flammability of these gases. Flammability is a property, which means it doesn't change for a substance. Some gases are flammable, which means a flame in them gets brighter or bursts into flames. Some gases are not flammable, which means a flame goes out in them. The gas from the elephant's toothpaste made a flame burn brighter so it is flammable and this means it can't be any of the non-flammable gases like nitrogen, argon, carbon dioxide, neon, helium, air, or carbon monoxide" (Teacher Edition, page 295).

Suggestions for Improvement

N/A

**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: Extensive

The reviewers found extensive evidence that lessons fit together coherently to target a set of performance expectations because student questions drive each lesson to build an understanding of core ideas and concepts. Students revisit the unit phenomenon and driving question multiple times, taking stock of how well they can explain the phenomenon, and creating key linkages across the unit. There is guidance on how to recognize what students figure out in a lesson and how to identify what new questions can motivate the next investigation.

The Driving Question Board (DQB) is a running record that documents students' questions based on their observations, and students revisit the DQB throughout the unit to reflect on their learning. For example:

- Lesson 1: Guidance is provided to support the cultivation of new questions arising from related phenomena or prior experiences. The teacher explains to students how to create the DBQ. Students form a scientist circle, and each student shares their question and as a class sorts their questions into categories or themes. Based on the questions on the DQB, students develop initial ideas for future investigations on the "Ideas for Investigations." Some of the initial suggestions are used right away in order to "provide a powerful sense of shared enterprise and agency for students" (Teacher Edition, page 48). The Ideas for Investigations serves as an initial draft and the ideas shift as students gather more evidence. "Students will think of new things to investigate that will become targeted at answering the most pressing and relevant questions emerging from their work at that point in the unit" (Teacher Edition, page 48). The teacher also keeps track of the ideas and puts a check mark if the investigation is based on an idea that the students came up with. This provides ownership for the students and allows the lessons to build on prior lessons.
- Lesson 6: Students are asked to identify what they have learned on the DQB. "Now that we have figured out some things about different substances and ways to identify them, let's take stock of

what questions on our DQB we could answer. With your group, look through the questions from our DQB. Mark questions your group feels you can fully answer with evidence with a ✓✓ (tell students this represents questions that we feel we have made progress on and we have evidence for), questions your group can partially answer but need more evidence with a ✓(tell students this represents questions we feel we have made progress on but don't yet have sufficient evidence for), and questions your group can't answer yet by leaving them as is (tell students these are the questions they feel we haven't made any progress on yet)" (Teacher Edition, page 147). This process allows students to recognize what they have figured out in a lesson, but also what questions are left unanswered/new questions to motivate the next investigation.

- Lesson 12: Students revisit the DQB and "share an estimate of what fraction or percent of questions they think we have answered." Teachers are reminded that "Revisiting the DQB at the end of the unit helps students see the progress they made toward answering questions that are important to them at the outset of the unit" (Teacher Edition, page 244).

Students revisit the phenomenon at multiple points throughout the unit to revise/build upon their current explanations. For example:

- Lesson 4: "Say, we have been making a lot of progress on our lesson question. However, we haven't taken time yet to summarize all of the things we've figured out, or the sources of data we have explored to do that figuring out. It's important for us to reflect and organize our thinking so we can celebrate our work and plan our next steps" (Teacher Edition, page 102). Students create a chart to record questions they have been working on, how they investigate the questions, the evidence that helps them answer the questions, and the key ideas, such as "properties don't change for a substance" (Teacher Edition, page 104).
- Lesson 7: Students take stock of what they have learned by refreshing their memory on what they figure out in Lessons 1–5 and what they should add to their class consensus model. "We work as a class to summarize and review all of the science ideas we have figured out through the investigations we have done so far to put all the pieces together. We develop a new way to represent what we figured out, using an input/output table. We identify an unanswered question about where the particles that make up the substance(s) of the gas came from and individually develop a model to try to explain this" (Teacher Edition, page 6). This meta-cognitive reflection helps students become aware of what they know over time and revise their thinking.

The Progress Tracker (Lessons 3, 4, 5, 8, 11, and 13) is a central document where students keep track of all the evidence in one place. "This is the place where students will individually reflect on their progress and also add key consensus modeling work completed by the class" (Teacher Edition, page 49). Students record the new evidence they collected, reflect on the question they were trying to figure out, and record what they figured out and how they learned it. For example:

- Lesson 3: "Individually, have the students add a row to their Progress Tracker to note what they have figured out and how this will help them figure out what causes bath bombs to behave the way they do. Encourage them to add what they have learned about solubility" (Teacher Edition, page 94).
- Lesson 4: "This Scientists Circle discussion includes time to record Key Model Ideas in our Progress Trackers because as students develop the practice of argumentation, it will be critical that they

understand and are able use the Key Model Ideas the class agrees upon in their oral and written argumentation. You will see prompts and suggested responses, then pauses for students to interact with these ideas with a partner" (Teacher Edition, page 103).

- Lesson 11: "Give students the remaining time to update their individual Progress Trackers" using the framing question, "How do Dalton's models of the particles that change in a chemical reaction compare to the ones we developed?" (Teacher Edition, page 218).

Students develop scientific principles or "Key Model ideas" over the course of the unit (Lesson 2, 4, 5, 8, 11, and 12) and use them to construct argumentation. For example:

- Lesson 4: "Going forward let's make sure to keep a record of these new Key Models Ideas in your Progress Trackers as we figure them out. That may end up being a useful reference for you as you develop future arguments, explanations, and models" (Teacher Edition, page 104).
- Lesson 5: "Updating the Key Model Ideas poster. Co-construct a key idea about density that says something like, 'Less dense gases (and liquids) float upward when surrounded by denser gases (and liquids); and denser gases (and liquids) sink downward when surrounded by less dense gases (and liquids).' Add this to the Key Model Ideas poster. Remember it is important to use the wording your class comes up with for this Key Model Idea whenever possible" (Teacher Edition, page 133).
- Lesson 8: "Let's see if we can summarize what we all are saying happens to the particles of the original substances...Though we have many different representations for what could be happening to result in these different particles in the end, we all think something happens to the original substances. Let's summarize that "something" in a couple of words and add it to our Key Model Ideas poster" (Teacher Edition, page 172).

An exit slip is used to reflect on learning and support the cultivation of new questions arising from related phenomena. An exit slip consists of three main questions:

- What else should we investigate about these substances or try to do using these substances?
- What is one new question you have based on the investigation we did today?
- What was one new idea you heard from a classmate?
"This exit ticket structure is one you should use often, even if we do not specifically call out this structure. The student responses to these questions will allow you to assess students' sense of coherence in the science content storyline, their curiosity, and how they are working with other classmates' ideas in their learning community. Since this is an individual task, it will give you a good measure of this from each student. Additionally, this structure will communicate to your students that you value what they think and wonder about related to the science ideas you are focusing on in the unit" (Teacher Edition, page 95).

This unit builds toward the following PEs:
**MS-PS1-1**: Develop models to describe the atomic composition of simple molecules and extended structures.
**MS-PS1-2**: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

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**MS-PS1-5**: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

The lessons work together to provide sufficient opportunity for students to build proficiency in all of the PEs. For example:

- Lesson 11: Students study molecular models of simple molecules, such as water, carbon dioxide, methane, etc., and complex molecules with extended structures, such as table salt and sucrose.
- Lesson 13: Students compare different molecules from the Odor Lab and notice how their molecular compositions are different.
- Lesson 4: Students test different combinations of ingredients in a bath bomb and figure out that the gas bubbles are made of a substance that is different from the original substances.
- Lesson 10: Students add energy to water with electricity and find out that two different gases with different properties are produced.
- Lesson 12: Students use molecular models to represent chemical reactions and figure out that atoms don't disappear because the mass of the bath bomb stays the same before and after the reaction in a closed system.

Although MS-LS1-8 is also claimed in this unit, students are not extensively developing this PE, and the author states that this PE "will be developed over three OpenSciEd units: 6.1, 7.1, and 8.2" (Teacher Edition, page 13).

Suggestions for Improvement

N/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

The reviewers found adequate evidence that links are made across the science domains when appropriate because the unit focuses on the physical science domain and can be fully addressed within that domain. There is one connection to Life Science, **LS1.D Information Processing**, but the connection made doesn't fully convey how ideas from different domains work together to explain the phenomenon, and CCCs are not intentionally used to make the connection.

The following examples are strong evidence for this criterion:

- The DCIs, **PS1.A** and **PS1.B,** are addressed in great detail throughout the unit. In the first half of the unit, students investigate the bath bomb reactions to identify what the gas bubbles are

made of using property data. In the second half of the unit, students examine the reaction and the conservation of matter at the molecular level.
- There is one connection to the Life Science Domain – **LS1.D: Information Processing (Grade 6–8):** *Each sense receptor responds to different inputs (~~electromagnetic, mechanical~~, chemical), transmitting them as signals that travel along nerve cells to the brain. ~~The signals are then processed in the brain, resulting in immediate behaviors or memories~~.* It is mentioned in the Teacher Edition that "we are not getting into the other ways a human receives messages through the other sensory receptors. And we will not be going into the relationship between such signals and memories" (Teacher Edition, page 250). However, this partial element is addressed in only a single lesson (Lesson 13). In this lesson, students read an article, "How do we detect odors," and explain in their notebook, "what an odor is and how we detect odors" (Student Edition, page 50). Students are not connecting this new learning to explain the bath bomb reaction and the lesson is not needed for students to figure out the phenomenon. There is also no apparent connection made between the Physical Science and Life Science DCIs through Crosscutting Concepts.

Suggestions for Improvement
- Encourage the use of a CCCs, such as **Cause and Effect,** to make connections between the DCIs of different disciplines. Even if the unit phenomenon can be fully addressed within one science domain, CCCs can be intentionally used to connect to other disciplines in previous units.
- Consider providing guidance for the teacher to use the Odor Investigation activity as a precursor for the middle school Information Processing element. Consider moving this activity early in the unit where students are first observing the bath bomb and use odor as a physical property to identify pure substances.

**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

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 students use grade level mathematics and reading skills to explain and understand the phenomenon of the bath bomb reaction. The provided texts help students to develop understanding and explanations of the scientific concepts and phenomena. There are also multiple opportunities for high-level verbal discourse in a variety of formats and scenarios (partners, small group, and whole class discussions).

Grade appropriate Common Core Standards for ELA are deliberately utilized throughout the unit, with support for teachers provided in the "Making Connections" sections in order to make these connections clear. The following examples are evidence for this criterion:

- **CCSS.ELA-LITERACY.SL.7.1.C** *Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.*
  - Lesson 1: Students share their initial questions for the DQB and link their question to someone else's question. The teacher "presses students to try to talk through his/her own thinking. This is a key way to emphasize the importance of listening to and building off each other's ideas and to help scaffold student thinking" (Teacher Edition, page 50).
- **CCSS.ELA-LITERACY.W.7.1.** *Write arguments to support claims with clear reasons and relevant evidence.*
  - Lesson 2: Students are asked to write a well-supported argument. "They will make a claim, support their claim with evidence, and provide reasoning to connect their claim with any relevant key model ideas to show why their evidence supports their claim" (Teacher Edition, page 74).
  - Lesson 5: Students argue from evidence, "what gas(es) could be produced by a bath bomb," by citing relevant sources of evidence and using the anchor chart to help them include important ideas.
  - Lesson 14: In this summative assessment, students construct a scientific claim explaining marble changes in the Taj Mahal using evidence from the lab investigations and Key Model Ideas to support their arguments.
- **CCSS.ELA-LITERACY.SL.7.1.B** *Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.*
  - Lesson 1: Students share initial models in small groups and follow the discussion protocol. Students note similarities and differences between the models. They make a small check mark on their diagram, noting that it is similar and add a question mark if the group is confused about that part of the model.
  - Lesson 5: Students engage in small group discussion using the Discussion Protocol. Specific roles are assigned with a list of tasks (if you are the one sharing vs. if you are not sharing). Students give their classmates feedback by snapping fingers when they hear evidence and tapping feet when they hear the use of a Key Model Idea. Students also share whether they agree or disagree with their classmate's claim and explain why (Lesson 5, Handout Discussion Protocol Density).
  - Lesson 12: Students compare models and explanations in small groups. They use the given discussion protocol to make sure everyone shares and receives feedback on their model (Lesson 12, Slide A).
- **CCSS.ELA-LITERACY.SL.7.1**: *Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on other's ideas and expressing their own clearly.*
  - There are different grouping strategies, ranging from turn-and-talk/discuss with a partner, lab group/small group discussions, to Scientists Circle/whole-class discussion. Turn-And-Talk and small group discussion occur in almost every lesson that allows all students to surface their idea and receive peer feedback. Scientists Circle takes place when students are engaging in consensus discussion as a large group and suggested prompts are provided to the teachers to guide the discussion.

- **CCSS.ELA-LITERACY.RST.6-8.2**: *Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.*
    - Lesson 8: The article titled, "Dalton's Investigations," provides both textbook-style information as well as an excerpt from Dalton's journal. Students are provided with an active reading strategy. "Tell students that as they read, they should keep track of ideas or questions they have by writing them on the handout. They can write them in the margins or anywhere else there is room." They then "summarize what they figured out in their Progress Trackers when they finish, including new ideas/questions that the reading led them to consider, even if they weren't specifically mentioned in the text" (Teacher Edition, pages 170–174).
    - Lesson 11: The article, "A summary of some historical investigations and discoveries into the particle nature of matter," explores Dalton's findings and provides students the opportunity to interpret diagrams/models.
    - Lesson 13: Students read, "How do we detect odors," and use the information to help answer two questions: "1. Why do different substances have different odors? 2. How do we detect odors?" (Teacher Edition, page 252).
- However, while the readings provided do ensure a bit of variety in modality, they still primarily represent a textbook-style approach to presenting information.

The materials include prerequisite mathematics concepts necessary for the unit. Students utilize grade appropriate mathematics to figure out related phenomena. In Lesson 9, students use the following two mathematics concepts to figure out the density of pure substances:

- **CCSS.MATH.CONTENT.7.RP.A.2.A:** *Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table or graphing on a coordinate plane and observing whether the graph is a straight line through the origin.*
- **CCSS.MATH.CONTENT.7.RP.A.2.B:** *Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships.*
    - Lesson 9: Students calculate a mean of class data and plot mass vs. volume data for two different substances (glycerin and rubbing alcohol). The teacher is advised to coordinate with the 7th–grade mathematics teacher on the learning targets. The teacher is provided with prompts to help students make connections to mathematics, "Say, you've seen straight line relationships like this before in math. It looks like this line goes through 0, 0. When that is the case, we call this sort of pattern a directly proportional relationship. Directly proportional relationships have a constant unit rate—that means as one quantity changes, the other changes in a predictable way. We can find the unit rate for this graph by taking any coordinate point on the graph and dividing the y-value by the corresponding x-value. In our case, that would be any amount of mass in grams divided by a corresponding amount of volume in mL. This will give us the unit rate in grams per mL, which will be the density of the substance. Let's find the density of water from the relationship between mass and volume for a few different coordinates from our graph" (Teacher Edition, page 189).

Suggestions for Improvement

- Consider incorporating other types of texts, such as news articles, adapted scientific journal articles, and websites in addition to the articles provided.

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

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

# Bath Bombs: How Can We Make Something New That Was Not There Before?

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## 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

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students experience phenomena as directly as possible, the materials are structured in a way that value the funds of knowledge that students bring to the classroom, and teachers are supported in connecting student questions to targeted learning.

Students are provided with opportunities throughout the unit to bring their prior knowledge to explain what is happening to the bath bomb and provide ideas for how it can be investigated. Evidence related to this criterion include:

- Lesson 1: Students engage in a turn-and-talk and address the following questions: Have you ever heard of bath bombs before? What is your experience with bath bombs? (Student Edition, page 3). This provides students an opportunity to discuss their prior experiences with the bath bombs. In addition, students are able to experience the phenomenon firsthand by examining some homemade bath bombs closer and creating a "I Notice/I Wonder" T-chart.
- Lesson 5: Students are asked to share "Gas-Related Phenomena." "Tell them to list any experiences they have had with different kinds of gases. These can be gases that are used in different types of systems to make different things happen" (Teacher Edition, page 123). Students design an investigation to experiment with different ingredients in a bath bomb and analyze properties of different pure substances. Using patterns from the data, students eliminate the gases that are not possible candidates. Throughout this process students are acting as detectives and engaging in competing claims to explain the phenomenon.
- Lesson 13: Students are asked, "Are there times that you have smelled something without being able to see where the odor is coming from, but you could still identify what the smell was coming from?" and the teacher is guided to "Have some students share their experiences with smells that are familiar to them" (Teacher Edition, page 251).

Students are able to experience the phenomenon firsthand, as indicated below:

- Lesson 8: Students read about Dalton and other scientists who had similar questions as those that have been generated by the students. "I have a short reading that summarizes some related phenomena scientists observed in the past, where a gas formed and they had similar questions about what was happening at the particle level in those cases. How might comparing our ideas with the questions and ideas for investigations they came up with when they were thinking about the same sort of stuff help us make progress on the questions you wrote?" (Teacher Edition, page 174). In the following lessons, the class repeats the experiment they read about to answer the same questions that were asked by Dalton and the other scientists.

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

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas because student ideas drive most of the instruction in the unit. Students share their ideas to build upon prior understanding. The teacher acts as an expert facilitator, drawing out student ideas while coordinating movement toward targeted learning. Throughout the unit, students use others' ideas that were shared in class through discourse and review models constructed during the learning sequences to improve or change their own thinking.

Students provide support to others and through discourse elicit additional ideas which students build upon to develop a deeper understanding and revise thinking based on peer and teacher feedback. For example:

- Lesson 1: Students use their ideas and cite shared ideas of others. "Prepare to compare individual model-based explanations. Take a moment to have a short conversation about why we want to look at each other's models and explanations. Ask students: What can we learn from looking at each other's models and explanations.... We want to use our time to see what other people in the class are thinking and how they are thinking about the cause of the changes we saw in the bath bombs last time. We don't need to have the same ideas because we all think differently. But we can learn from one another by closely looking at our classmates' work. We are going to use this time to study their work closely and see if it helps our own thinking" (Teacher Edition, page 38). When students compare their initial model, they put a check by parts of the model that are similar to their peers and question mark if it's different.

- Lesson 2: Students are facilitated through a discussion about where the gas comes from and then are instructed to discuss the claims with a partner. “After 3 minutes, have students use a dialog like the one below to share the claim they have picked and why” (Teacher Edition, page 71).
- Lesson 6: Students individually construct their arguments. The “Assessment Opportunity” box says, “use elements to look for in students’ written arguments for guidance on what to look for in their written argument. Use this guidance to provide feedback to students on their written arguments” (Teacher Edition, page 146). This allows students to clarify their understanding based on teacher feedback.
- Lesson 12: Restating is used to support listening, for example, “Asking students to restate what another student has said supports the goal of students listening carefully to each other so that they can work with other’s ideas” (Teacher Edition, page 111). The students have to restate whether they agree or disagree with each idea suggested. Students then incorporate peer feedback to improve their models (Lesson 12, Slide A).
- The discussion protocol used in Lesson 5 and Lesson 12 provides a strong opportunity to respond to peer feedback. “Think about the questions you had about your model. Listen to other’s ideas and see if you need to use some of their ideas to improve your model” (Teacher Edition, page 231).

Unit materials suggest strategies to include student voice and equitable participation. For example:

- Lesson 1: Explicit strategies are embedded to include student voice. “To ensure that all students share ideas, say, “To make sure we have everyone’s ideas up here, I will pass a marker to the first person on the edge of the circle. The student with the marker should share one idea they have. I will write it up and number it. That student should pass the marker to the student next to them. The second student then shares an idea. If the idea is on the poster already, the student should identify which idea is similar and how it is similar. I will then put another tally mark next to that idea” (Teacher Edition, page 47). This ensures that all students' ideas are represented on the poster.
- Lesson 5: The teacher sets the expectation that everyone needs to participate and provides strategies to practice active listening skills. “Make sure they understand that everyone in the group will share their ideas in the form of making a claim about one gas that could be from the bath bomb or one gas it couldn’t be. All students will participate in giving feedback to their peers. Have students practice snapping their fingers and lightly tapping their feet” (Teacher Edition, page 137).
- Lesson 7: Strategies are provided to ensure equitable participation. “If some students are not sharing, use strategies such as Turn-and-Talk or Stop and Jot to provide students a minute to formulate their ideas before sharing with the whole group. You can also provide a quiet minute before each piece of the model is developed to ask students to look back in their notebook for pieces of evidence that support what they want to add to the model. The teacher also checks in with the students after the consensus model ‘who feels like we have not heard or represented their ideas in our revisions?’” (Teacher Edition, page 162). This shows that the teacher is recognizing the importance of everyone’s contribution and encouraging all students to share.

- Strategies are provided on how to set up the "Building Understanding Discussion." "Asking students to restate what another student has said supports the goal of students listening carefully to each other so that they can work with others' ideas. This move can feel odd to students at first, so it will help if you let them know ahead of time that you will be asking this. It can also help to support this type of collaborative talk in the classroom to have sentence starters up on a bulletin board, or on a handout students could tape in their notebook and refer to" (Teacher Edition, page 111).

The use of norms in the classroom sets up a safe environment for all students to participate and allows for personal reflection among students. For example:

- Lesson 1: When students develop an initial consensus model, the teacher helps students develop a shared understanding of each norm and asks students to clarify, modify, or develop a new norm. Students choose a focal form to concentrate on during class discussion and reflect on their norms at the end of the lesson through an exit slip. On the exit slip students focus on "equitable" and reflect on why it is important to listen to what other people say. This routine ensures that students listen to their peers and use their peer feedback as part of their learning. It also allows students to self-monitor their behavior and contribution (Lesson 1, Slide L).
- Lesson 3: "If you notice some students not participating, or not being included, remind the small group of the class norms and ask them how they could alter what they are doing so that all of them are contributing members of the investigation" (Teacher Edition, page 88).
- Lesson 4: Students "choose a norm they will intentionally work at and monitor today to help our learning community grow stronger and more productive for everyone" (Teacher Edition, page 102).

The unit contains opportunities for students to transfer their learning to new phenomena. For example:

- Lesson 14: Students are asked to transfer their learning to explain the erosion of the marble on the Taj Mahal. "Say, We've revisited this poster a few times to remind ourselves that the work we were doing with the bath bomb should ultimately help us figure out how to explain some of these other phenomena too. This led us to see if we could apply our ideas we developed early in this unit to explaining a related phenomena - elephant toothpaste. It led us to explore other bubble-producing phenomena like boiling and adding electricity to water to produce hydrogen and oxygen gas. Each of the phenomena we investigated early in the unit involved gas production when a new substance was made. And in lesson 12 we figured that the chemical reaction that occurs when the bath bomb is added to water produced not only carbon dioxide gas, but also water and sodium citrate. So chemical reactions don't only produce gases, they can also produce liquids and solids too" (Teacher Edition, page 261).

Suggestions for Improvement

- Most of the feedback students receive is based on oral feedback. Consider including additional opportunities to respond to varied forms of teacher and peer feedback, such as written feedback, gallery walk, etc.

**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

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 have with all three dimensions for the core learning of the unit and are designed to build upon typical levels of proficiency that students have with each of the three dimensions.

Evidence related to building on students' prior learning and students building proficiency in SEPs include:

- "What are the Focal Science and Engineering Practices (SEPs) for this unit?" sections outline what experience with SEP elements students should have from previous units or grade levels (Teacher Edition, page 14–17).
- The first half of the unit, students try to figure out *what* is happening when a bath bomb reacts with water. In these lessons, students are engaging in argumentations as they gather evidence of this chemical reaction. In the second half of the unit, students figure out *how* the reaction happens to try to explain the unobservable mechanism. This process supports students in developing the skill to construct explanations based on evidence and incorporating Key Model Ideas to explain the why/how behind the bath bomb chemical reaction.
- Prior learning for **Analyzing and Interpreting Data** is mentioned at grades 3–5. "Students in grade 3–5 represent data in tables to reveal patterns, in 6–8 grade students need to be able to construct graphical displays of data to identify relationship. Since this is the first unit in 7th grade, the teacher and students co-construct a data table together." The teacher is providing scaffolding to help students develop this practice and move them toward the middle school grade band (Teacher Edition, page 58).

Evidence related to building on students' prior learning and students building proficiency in DCIs include:

- "What should my students know from earlier grades or units?" section outlines what DCIs and ideas students should have from previous units or grade levels (Teacher Edition, pages 13–14).
- Each lesson includes a section "Where We Are Going and NOT Going" that explains what prior DCI knowledge students should have and how the lesson will build upon the knowledge.
- Teacher materials provide insight as to where students should be in their understanding of DCIs. For example, in Lesson 2, "At this point in their learning, students are not expected to differentiate between weight and mass. The distinction was introduced in Storms Unit and they will revisit that distinction in OpenSciEd Unit 8.1: Why do things sometimes get damaged when they hit each other? (Collisions Unit), two contexts where the role of forces is important to explaining the phenomena. That is not the case here. The teacher guides and other materials in this unit will refer to mass, but if your students talk about weight instead, you do not need to take time now to explore the difference between them" (Teacher Edition, page 60). In Lesson 3, "Students should

agree from what they learned in previous years that when something dissolves in water, the water can be evaporated off and the original substance will still be there. (This should be something that was learned in 5th grade. However, if your students haven't learned it yet, you may wish to take the time to ask how to collect evidence supporting the concept that when something dissolves in water, we can let the water evaporate and get the original substance back.) An example dialog is shown below" (Teacher Edition, page 89). In Lesson 10, "This is also the first time that students are bridging the idea that there must be new particles being produced as an explanation for the formation of a new substance, based on evidence of changes in properties" (Teacher Edition, page 199).

- The Key Model Ideas helps students build progression toward understanding of the DCIs. Students keep a record of what they already know on a Key Model Ideas poster. In Lesson 2, "This connection to prior knowledge is intentional so we can help students build a foundation on those key model ideas about particles, matter, and mass conservation at the beginning of this unit. Then, as the unit progresses, we can help students extend that thinking to develop evidence for a different kind of particle (the atom), which is a fundamental building block of larger particles (molecules) that make up matter. This reuse and extension of ideas is a key feature of developing a coherent learning progression for students over multiple years in NGSS (Teacher Edition, page 55). "Let's take a minute to remember some of the key ideas that we figured out about gases from earlier units. We are going to label these Key Model Ideas because these are ideas we have figured out and can reuse in the new models we develop in this unit to explain what is going on with the bath bombs" (Teacher Edition, page 57). In Lesson 4, "OK, let's recognize that we are using another key model idea here. We are saying properties don't change for a substance. Let's add that to our Key Model Idea poster. (Add this idea to the poster): Properties don't change for a substance" (Teacher Edition, page 104). In Lesson 5, "Co-construct a key idea about density that says something like, 'Less dense gases (and liquids) float upward when surrounded by denser gases (and liquids); and denser gases (and liquids) sink downward when surrounded by less dense gases (and liquids).' Add this to the Key Model Ideas poster" (Teacher Edition, page 133).

Evidence related to building on students' prior learning and students building proficiency in CCCs include:

- "What are the Focal Cross Cutting Concepts (CCCs) for this unit?" section outlines what experience with CCCs elements students should have from previous units or grade levels (Teacher Edition, pages 18–20).
- Students develop the skill of looking for patterns over the course of the unit. In the first half of the unit, students look for patterns of macroscopic occurrences in the bath bomb phenomenon. Then they analyze some property data of different substances and use this crosscutting concept to argue which substances cause a gas to form from the bath bomb (Lessons 1, 2, 3, 5). Then students look for patterns at the macroscopic level to explain what is happening at the microscopic level in the second half of the unit (Lesson 9 and 12). "This is an important advancement in using the cross-cutting concept of patterns, related to the idea that macroscopic patterns are related to the nature of microscopic and atomic-level structure" (Teacher Edition, page 199). However, students are repeatedly prompted by the teachers to use patterns instead of becoming more independent in using this thinking toward the end of the unit. For example:

    - In Lesson 3, "Guide students to note patterns and categorize them" (Teacher Edition, page 85).
    - In Lesson 9, "Ask students to share some of the patterns they noticed" (Teacher Edition, page 187).
    - In Lesson 11, "Prompt students to turn and talk with a partner about the patterns they notice" (Teacher Edition, page 222).
- Students build progression on the thinking of **Developing and Using Systems and System Models**. In Lesson 1, "students use their models in What Happens to a Bath Bomb When Put in Water? and Initial Model-based Explanation to represent systems and their interactions. In these two models students represent the matter inputs and outputs in an open system (a bowl of water) in their initial models. The two models students develop are designed to foreground accounting for where the matter in the system went to and open up the possibility that maybe the matter in the system wasn't conserved (even though it was). At the end of this model development, the processes we are trying to track--what we started with (inputs) and what we ended with (outputs)-- as well as what happened in between, help lay the groundwork for a representation of reactants vs. products in chemical reactions that students will uncover in the later half of the unit" (Teacher Edition, page 37).
- Students build progression on their thinking of "*Matter is conserved because atoms are conserved in physical and chemical processes*" from macroscopic pattern to microscopic level. Students begin to develop and use the idea of conservation of matter in physical and chemical processes in Lesson 2 by figuring out that the gas (a type of matter) is not created but must come from something that is there to begin with. In Lesson 6, students use the idea of conservation of matter in chemical processes and learn that it couldn't have just disappeared on the transfer task. In Lesson 12, students "build on the concept that the macroscopic patterns of chemical reactions are related to both the nature of microscopic patterns, as well as the atomic-level structure of the substances involved in those reactions" (Teacher Edition, page 19).

Throughout the unit, suggestions are provided for teachers to offer additional scaffolding for students who may need additional support in building proficiency. For example:
- Lesson 5: "For students who need additional scaffolding for this explanation, use Alternate: My Predictive Explanations for the Gas from a Bath Bomb that has sentence starters and other supports (Teacher Edition, page 134).
- Lesson 6: "For students who need additional scaffolding for the written argument, use Alternate: Explaining another phenomenon that has sentence starters and other supports for students" (Teacher Edition, page 146).

Suggestions for Improvement
- Consider identifying what additional layers of CCCs students are adding throughout the unit, and how students are using the CCCs more independently toward the end of the unit.

**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

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 the teacher to clarify potential alternate conceptions that they or their students may have.

The materials provide strong support for teachers to ensure scientific information is accurate and any potential misconceptions are addressed. Evidence related to this criterion include:

- Each lesson has a "Where we are going and NOT going" section which describes how students are building toward the PE and how the lesson fits in the storyline. These sections also point out when misconceptions may arise which will be addressed at later points. For example:
  - Lesson 2: "In the second investigation you are using a rigid airtight container to mass the system, rather than a baggie to ensure that the overall volume of the system doesn't change measurably when the bathbomb mixes with the water. This volume change happens when using a baggy, and this would add a confounding variable when weighing the baggy, as it leads to an additional amount of upward buoyancy force on the system. This reduces the overall weight registered on the scale. Such a result would take time to reason out, and would not be a productive avenue of investigation at this point in the unit. This is why additional guidance is provided in the lesson to motivate using a rigid airtight container for recording the mass of the system" (Teacher Edition, page 55).
- At points throughout the unit, key concepts are called out to ensure they can be emphasized. For example:
  - Lesson 3: "The observation that each of the ingredients by themselves did not produce bubbles in the water is an important idea that needs to be emphasized by the class and remembered by students through the end of the unit. Students will later model what particles are reacting by breaking apart and rearranging into new particles. Although this reaction takes place in water, the ingredients did not react with the water to produce bubbles" (Teacher Edition, page 95).
  - Lesson 5: "It is not yet important that students determine that this is a chemical reaction. At this point, they only have a partial understanding of this idea: that certain combinations of substances, when mixed together, may cause a new substance to form. But they will need some additional data to support their new understandings about this idea. It is not important that students understand the role of water in this process. Students already know that water causes baking soda to dissolve (break into smaller pieces), and that it does the same for citric acid. It could be reasonable to assume that one or both substances must be broken down into smaller pieces in order for the gas to appear" (Teacher Edition, page 101).

- Guidance sections provide teachers with information that can be used to clarify understanding of scientific information. For example, in Lesson 3, "Students may question why 'in water' follows 'solubility.' Students may not have thought about dissolving the solid substances in liquids other than water, but a substance's solubility depends on the liquid it is dissolved in. It also depends on the temperature of the liquid. Discuss this with your students if they bring it up. If students have not thought of or tried dissolving some of the solid substances in oil yet, you may want to give them the opportunity to do so now. The solubility of the substance in other substances, besides water, that are also liquids at room temperature is also a property" (Teacher Edition, page 92).

- Following discussion prompts and sample student responses, teachers are provided with information that they might use if students bring up specific information. For example, in Lesson 5, students share related gas phenomena in that "students may suggest odor as a way to identify the gas because they may have smelled natural gas from a gas leak or they may remember that some bath bombs had an odor. Remind them that we think odor might be considered a property. Tell them that natural gas has an odor because another substance is mixed into it that has a rotten-egg-like odor to aid in the detection of gas leaks — the natural gas itself is actually odorless" (Teacher Edition, page 124).

- In Lesson 11, students are provided with circle cut outs of paper and asked how they can "represent a water particle, a blue circle, to make two different kinds of particles from this one type of particle" (Teacher Edition, page 214). The teacher is told to anticipate students "1. Ripping a water particle into smaller pieces. 2. Ripping a water particle into smaller pieces and sticking/recombining those pieces together into different shapes/combinations." Using a solid blue circle and ripping it apart can promote the misconception that water is a solid particle that can be ripped into smaller pieces versus one that it is composed of individual atoms held together by bonds. Using circles and having students rip them apart into different shapes can be misleading and reinforce misconceptions since the shapes change, the colors remain and there is not a key to help to accurately interpret the reaction.

Suggestions for Improvement

- In Lesson 11, in order to reduce misconceptions, consider using paper structures that represent the atoms that make up the substances, symbolizing each element with its own color or representation like those used later in Lesson 11 (Teacher Edition, pages 220 and 221) or in Lesson 12, Handout 2D Molecule Cut. Using molecular models versus a solid paper circle would more accurately represent chemical reactions; particles (atoms) are rearranged into new and different substances, they are not created nor destroyed. If paper circles can't be used, consider highlighting the need to revisit with students in order to discuss the limitations of the model as outlined in the Student Ideas section of the rubric and supporting materials.

**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

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction because multiple differentiation strategies are included; materials address the needs of English language learners, learners with special needs, struggling students, and some extension activities for students who have already met the performance expectations.

Scaffolds and supports are suggested throughout the unit using Universal Design for Learning. These supports are often found in the “Attending to Equity” sections in the margins of lessons. For example:

- Graphic Organizers are utilized for initial models
- Lesson 2: “If you would like to offer sentence starters to support your students as they engage in writing, here are some examples, which are also provided on optional slide X” (Teacher Edition, page 74).
- Lesson 5: The “Attending to Equity Section” states, “Universal Design for Learning: In addition to demonstrating the tests in real time, consider providing students access to the alternate videos of the investigations for students to re-watch or return to. These videos provide an additional option for representation that can help support students in processing the information and can be slowed down or re-watched as needed. Additionally if students have questions about what happened in the video, they can re-watch the video intentionally looking for evidence or data that could help them answer their question. This sets a purpose for them as they rewatch the video. Multiple students in the class may ask to see the video again after watching it once. If this is the case, then ask them why they want to watch the video again. What are they wanting to see or look for? Through asking these questions and making students verbalize and identify why they want to watch it again, you are increasing access and engagement with the phenomenon. If students can’t verbalize a reason they want to re-watch beyond just to see it again, then use your discretion as to whether you have time in your class period for this” (Teacher Edition, pages 126–127).

Suggestions are provided for students who are English language learners. For example:

- "Words we earn" and "Words we encounter" are provided to the students on the Word Wall. Students learn the words once they have developed an understanding of a science idea. Some key words are given to students as they encounter them in the reading or activity. Teacher includes definitions and pictorial representation next to the word. This provides visual support for emergent multilingual students and a central place where students and the teacher can often refer to. "Using a Word Wall to display important vocabulary is an effective strategy to support all students. Call attention to words that students use that are on the Word Wall, and if students struggle to find the right word to use, ask them to look at the Word Wall to see if there are words there that will help them" (Teacher Edition, page 90).
- Lesson 3: "Encourage students to express what they've learned using a mode that makes sense for them. For some emergent multilingual students, encourage them to use space to make sense in the language that they feel most comfortable using (Teacher Edition, page 94).
- Lesson 3: This is an opportunity to build literacy skills and also to provide support for emerging multilingual learners or struggling readers. Ask students, "What do the words 'dissolve' and 'soluble' have in common? Focus students on just the word, and not what each means. After students have had a chance to respond, either support their ideas if they emerge or say, Both words have 'sol' in them. One meaning of 'sol' is to loosen. This makes sense because we loosen little parts of the solids away from each other until they are so small we cannot see them" (Teacher Edition, page 89).
- Lesson 5: "Scaffolds such as sentence starters and images can model and facilitate particular oral or written language production skills. Such scaffolds may be of particular benefit for emerging multilingual students to help them develop language skills to write or communicate their ideas to peers" (Teacher Edition, page 133).

Guidance is often provided for supporting students who may be struggling. For example:

- Lesson 2: "Supporting Students in Engaging and **Analyzing and Interpreting Data**: A grades 3–5 element of this practice is for students to enter data in tables and other displays to reveal patterns. Although this is an earlier grade level element for this practice, some learners may need additional practice with the thinking routines required to organize data collection in a table, particularly at the start of the year. This is an opportunity for you to support their developing mastery of this element so that they are prepared to meet the middle school elements for this practice. Including students in this process is essential to scaffolding student understanding of what data is important to collect and how to organize it" (Teacher Edition, page 59). In Lesson 3, the teacher is told, "Students often do not include enough details when recording data and observations. You can encourage them to do so by asking questions that include, I noticed you have white as a color for more than one substance. Can you be more descriptive?" (Teacher Edition, page 84).
- Lesson 4: "If students are struggling to consider the number of combinations or redundancies, you may want to talk through creating a chart with them rather than jumping to the one you already have prepared" (Teacher Edition, page 104).
- Lesson 5: "If students are struggling with looking at all the data on Some Common Gases at once, encourage them to cover the last 3 columns of data with a blank piece of paper to hide

those at first, and then after analyzing that part of the data table, slide the paper over to look at each subsequent column of data, one at a time" (Teacher Edition, page 105).

- Lesson 5: Students are asked to write an argument to answer the question, "What gas(es) could be produced by a bath bomb?" Lesson materials suggest that "For students who struggle with writing this argument, you could provide them with anonymized copies of a couple of exemplar student responses for them to annotate. Ask them to circle the claim, underline the evidence, and highlight the use of key model ideas in both. Ideally provide them two arguments that have different structure and different flow in how all of this is sequenced and connected together" (Teacher Edition, page 139).
- Lesson 9: Support is provided for students struggling with the relationship between liters and milliliters. "You can use a t-chart with equivalent values and ask students to notice patterns in the numbers. Students should notice that the numbers are related by multiplication or division of a common factor (1,000) depending on the direction in which they compare numbers across the table" (Teacher Edition, page 185).
- Lesson 9: Support is provided for students struggling to construct an explanation supported by evidence and reasoning. "If you notice students are not using key model ideas in their explanations or if they are struggling with where to find these, remind them that they can use what they have highlighted in their Progress Trackers and/or the key model ideas recorded on the classroom poster" (Teacher Edition, page 192).
- Throughout the unit alternate handouts are provided for students who are in need of additional support.

Suggestions are provided for students with special needs. For example:

- Lesson 1: Specific marker colors for the class poster are intentionally chosen to support students who are color blind to differentiate between the different particles. Rationale is provided that "Since we are working together to figure out what is happening at the particle level and what is different between the particles, it is important that all students can tell the difference between the different particles." This indicates that the teacher is paying attention to equity and ensuring all students have access to the information (Teacher Edition, page 29).
- Lesson 1: "Some students may have skin sensitivity issues. If this is the case, having non-latex gloves on hand for these students will be necessary and helpful" (Teacher Edition, page 35).
- Lesson 7: "The colors shown in the example poster included in the teacher guide for this class model were intentionally chosen to support students who are color blind to allow them to be able to differentiate between the different color bands/shades of the particles. Since we are working together to figure out what is happening at the particle level and what is different between the different types of particles, it is important that all students can tell them apart" (Teacher Edition, page 151).
- Lesson 13: "Check for allergies. If you have students who are allergic to vinegar, vanilla, lavender, menthol, or lemon, you will want to confirm their allergy is not airborne. If it is, they should use observations from a partner for the smelling portion of the lab. They will be able to participate still through looking at the accompanying molecular structure cards and the reading" (Teacher Edition, page 249).

# Bath Bombs: How Can We Make Something New That Was Not There Before?

# EQuIP Rubric for Science Evaluation

Suggestions are provided to extend the lesson in the event where students have expressed interest in learning more. However, these extension activities are not designed specifically for students who have met the performance expectations. For example:

- Lesson 2: "Your students might ask to use a microscope to observe the bath bomb more closely than they can with a hand lens. This is an extension that you may encourage if you have the time and available microscope(s). If you are not able to allow the students to explore with microscopes in your classroom, but you would like to offer this enrichment opportunity, optional slides D–H are provided with images of homemade and store-bought bath bombs taken through a digital microscope (Teacher Edition, page 57).
- Lesson 3: "Extension: Some students might want to keep track of mass in their investigation. For those that suggest they want to collect this data, encourage them to reason out why keeping track of mass might be useful. Then have students plan how and when they would incorporate taking mass measurements in their investigations. The following questions can be used to help facilitate this conversation with these students" (Teacher Edition, page 87).
- Lesson 4: "Extension Opportunity in the current layout, every combination will be tested twice. Students may not notice that. If they don't bring this up, then move on. If they do notice it, ask for a student to point out an example or two. If the class seems interested in this sort of math problem, you could give them a minute to calculate how many unique combinations there are. (There are 45 unique combinations.) Then say, If we were pressed for supplies, we might skip the duplicate combinations that groups would test. But we are more pressed for time, and having every group test their row is a quick and easy way to plan and would give us two data points for each combination. Because more data makes us more certain, let's go ahead with the plan of having your group do your assigned row" (Teacher Edition, page 106).
- Lesson 5: "Extension Opportunity Students may also notice that all of these gases have boiling points that are colder than room temperature. If students seem intrigued by this or want to talk about this further you could ask them to consider how this is connected to why these substances are a gas at room temperature. If students bring up wonderings about what would happen if you cooled these gases, you ask students to consider how these boiling points could be used to make predictions about which gases would turn into liquids if you cooled them down to a certain temperature. This gives students an opportunity to connect what they learned in Storms Unit about boiling point and condensation point being the same temperature for a certain type of gas in the atmosphere (a substance). This thought experiment is one that some students might reference in their response to the last question in Explaining another phenomenon or Alternate: Explaining another phenomenon in the next lesson. Cooling and heating mixtures to different temperatures to get the substances in them to change phase from liquid to gas and back again is a technique used to identify and isolate substances through distillation and refining" (Teacher Edition, page 126).
- Lesson 13: "Most likely some students will be highly interested if other living organisms also detect odors the same way we do. Or, there will be some students who are interested in odors and how they affect organisms. Encourage these students to do a little research outside of class to find out more about this and then make time for them to share with the class what they have figured out" (Teacher Edition, page 254).

# Bath Bombs: How Can We Make Something New That Was Not There Before?

# EQuIP Rubric for Science Evaluation

Suggestions for Improvement

- Consider providing more authentic extension activities for students who have met the performance expectations.
- Consider providing more explicit tools and strategies to support students who are above or below the expected level of proficiency for CCCs.

**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: Extensive

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time because in all lessons, students make progress towards elements of each dimension that help the students also make progress on the questions connected to the phenomena. There is also guidance to help students connect phenomena and questions across lessons.

Teacher guidance is provided throughout the lesson to provide guidance as to how to draw questions and connections out of students. At various points throughout the lesson, students have an opportunity to generate questions and build upon ideas related to the phenomenon. These opportunities result in coherence for the student and drive the learning across lessons. Some examples can be found below:

- Lesson 1: During the initial consensus model discussion, students share competing ideas about what happened to the bath bomb when it reacts with water. By eliciting and capturing areas of disagreement, this creates a need for students to investigate each hypothesis and gather evidence to support or refute the claim. Students' ideas are used to link their engagement across lessons (Lesson 1, Slide N).
- The DQB (Lessons 1, 3, 6, 12, and 13) and Ideas for Investigations are revisited throughout the unit. The DQB provides a structured support for teachers to draw out these connections from students and use these connections to motivate student learning. Students take stock of questions on the DQB and add new questions. Additional Guidance call out box is embedded in the Teacher Edition to remind teachers to make the connection between the activity and students' questions/ideas. Specifically, "returning often to students' initial ideas from the DQB and their suggestions for investigations is an effective way to support coherence for them and honor their contributions" (Teacher Edition, page 56). These call out boxes help teachers link the lessons together and make the unit coherent.

Throughout the unit, lessons begin by reviewing what students have figured out and where to go next. At the end of several lessons, students are provided with the opportunity to ask questions they feel still need to be addressed or propose future investigations. For example:

- Lesson 3: After students identify patterns in the ingredients in homemade and store bought bath bombs, they are asked to generate additional questions. "Now that the class knows the names of the ingredients, refer students to the questions on the slides to figure out what additional information they want to know about these ingredients to help figure out how bath bombs form bubbles. Now that we know the names of these ingredients, what do we want to know about them? How can we use the ingredients to help us figure out how the bath bomb makes gas bubbles? What could we eventually investigate using these ingredients?" (Teacher Edition, page 84). Students complete an exit slip and answer, "1. What else should we investigate about these substances or try to do using these substances? 2. What is one new question you have based on the investigation we did today? 3. What was one new idea you heard from a classmate?" (Teacher Edition, page 95).
- Lesson 5: After students identify the gas was produced by the bath bomb, new questions arise. "How is it possible that we have a new substance that was not there before?" This motivates students to think about what is happening with the particles of the substances to make gas (Lesson 5, Slide O).
- Lesson 6: "Even though we've made a huge amount of progress by reasoning about property changes, we still don't know how new substances are being produced. We still don't know what is happening at a particle level. We are going to have to shift to using some creative thinking about what could be happening at a particle level that could explain how this is possible along with everything else we know is happening in the system. Let's pick up here next time" (Teacher Edition, page 148).

Teachers are provided with prompts that can be used for summarizing and linking learning opportunities. For example:

- Lesson 10: "Let's take stock of where we are. We have tried both of the investigations we wanted to do with water based on what we read about. And you all just constructed an explanation based on evidence we collected that new types of particles were produced from water particles in one of the investigations. That seems directly related to the key idea we summarized at the end of Lesson 8, related to what had shown on our 'What is happening with particles when new substances are made?' poster. In our next class let's revisit that poster and evaluate those ideas in light of the explanations you constructed" (Teacher Edition, page 207).

Additional supports include instructional slides that help guide the learning process, instructional support videos, and the unit storyline document that includes a "Navigation to Next Lesson'' portion that explains how the current lesson connects to the lesson which follows.

Suggestions for Improvement
N/A

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

## Rating for Criterion II.G. Scaffolded Differentiation Over Time: Extensive

The reviewers found extensive evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time because the instructional materials provide clear guidance and supports for all students to engage in the SEPs in ways that not only integrate the other two dimensions, but also explicitly build an understanding of and proficiency in the SEPs over time through a variety of student approaches.

The focal SEPs, **Constructing Explanations and Designing Solutions** and **Engaging in Argument Using Evidence,** are developed explicitly throughout the unit with clear guidance and much scaffolding. For example:

- Students collect evidence through investigations to help them engage in argumentation about what happens to a bath bomb when it reacts with water in the first half of the unit. In the second half of the unit, students use what they have figured out to construct a scientific explanation on how the reaction occurs. Detailed guidance on the progression of each lesson is provided on pages 17 and 18 of the Teacher Edition.
- Lesson 2: "Since this is students' first chance this year to write a strong and convincing argument, take a moment to ask them how confident they feel about this practice. Use slide Y to present the question, on a scale of 4 (totally independent) to 1 (need lots of help with this), how are you feeling right now about writing a well-supported argument? Briefly explain what makes you feel that way and what help you could use as you develop this practice. Direct students to respond on the bottom or back of the page where they wrote their argument. Students will have another chance to reflect on their confidence with argumentation in Lesson 5 so you and they can consider their progress with this practice" (Teacher Edition, page 75).
- Lesson 2: Scaffold is provided to students early on how to construct an argument with evidence and reasoning. "Students often struggle with reasoning. If you need to support students with reasoning, ask them to look at the Key Model Ideas poster to see if there is an idea there they could use to explain why their evidence supports their claim. Students should recognize that "gas is matter that has mass" is a strong reason why their evidence supports their claim" (Teacher Edition, page 75). Possible sentence starters are provided to support students who may struggle with writing an argument.
- Lesson 4: "This Scientists Circle discussion includes time to record Key Model Ideas in our Progress Trackers because as students develop the practice of argumentation, it will be critical that they understand and are able use the Key Model Ideas the class agrees upon in their oral and written argumentation. You will see prompts and suggested responses, then pauses for students to interact with these ideas with a partner. The class will come back together and share before students record these Key Model Ideas in their Progress Trackers using their own wording. This activity should not be seen as note-taking. Instead, it is intentional time to discuss

and make sense of the Key Model Ideas we have agreed upon as a class and an opportunity for students to personally grapple with and assimilate these ideas to evidence they have collected before they record them individually" (Teacher Edition, page 103).

- Lesson 5: Students are provided with a scaffold for engaging in **Construction Explanations and Designing Solutions**. "We want to help students develop the practice of constructing a coherent explanation. This explanation includes both qualitative and quantitative relationships between variables that predict whether the gas would float upward or sink downward, as well as connections to a key model idea." A sentence framework with "What to look for in student responses" and "What to do" if students are struggling when they are forming these for the first time" (Teacher Edition, page 134).
- Lesson 9: "If you notice students are not using key model ideas in their explanations or if they are struggling with where to find these, remind them that they can use what they have highlighted in their Progress Trackers and/or the key model ideas recorded on the classroom poster" (Teacher Edition, page 192).

Within the unit, there is some teacher guidance as to how to develop specific SEPs for students with diverse abilities and through a variety of student approaches. For example:

- Lesson 2: Guidance is provided to support students in **Analyzing and Interpreting Data.** "A grade 3–5 element of this practice is for students to enter data in tables and other displays to reveal patterns. Although this is an earlier grade level element for this practice, some learners may need additional practice with the thinking routines required to organize data collection in a table, particularly at the start of the year. This is an opportunity for you to support their developing mastery of this element so that they are prepared to meet the middle school elements for this practice. Including students in this process is essential to scaffolding student understanding of what data is important to collect and how to organize it" (Teacher Edition, page 58).
- Lesson 5: "Universal Design for Learning: This discussion is one of many different ways students will express their understanding of types and forms of arguments they can make using property data related to gases. Other forms of expression in this lesson include: annotating Some Common Gases predicting and discussing the results of first-hand investigations as they write a predictive explanation using sentence scaffolds, verbally sharing their conclusions using a discussion protocol, snapping their fingers and lightly tapping their feet in response to oral arguments writing a final argument. Providing students varied and multiple ways to express their understanding helps support them in accessing, building, and ultimately internalizing the strategies used in arguing from evidence in general, and not just for this specific case and context" (Teacher Edition, page 125).
- Lesson 6: " For students who need additional scaffolding for the written argument, use Alternate: Explaining another phenomenon that has sentence starters and other supports for students" (Teacher Edition, page 146).

Suggestions for Improvement
N/A

## Bath Bombs: How Can We Make Something New That Was Not There Before?
## EQuIP Rubric for Science Evaluation

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

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

# Bath Bombs: How Can We Make Something New That Was Not There Before?

# EQuIP Rubric for Science Evaluation

## 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

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 because there are multiple and varied opportunities for students to visibly demonstrate their understanding of the three dimensions. The majority of scenarios are rich, based on specific, real-world, puzzling events that require students to use grade appropriate elements of each of the three dimensions in service of making sense of the phenomenon.

Throughout the unit, students are provided with opportunities to engage in 3D learning performances using authentic scenarios. These tasks are presented to students in multiple modalities. For example:

- Lesson 5: "This is an opportunity for assessing students' engagement in all three dimensions of NGSS to explain a phenomenon, related to a target of Performance Expectation (PE) MSPS1-2. In this PE, students are trying to develop an argument for whether a chemical reaction occurred. They are developing a precursor argument and part of the foundation that will be developed fully in future lessons. They are arguing for what new substances could have been produced in the gas from the bath bombs. In this assessment, students are using DCIs related to PS1.A: Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it. They are using the crosscutting concept of patterns (at a macroscopic scale), and they are developing an evidence-based argument based on their analysis and interpretation of data from laboratory experiments and known property information to determine the similarities and differences in findings" (Teacher Edition, page 139).
- Lesson 6: This lesson includes a transfer task where students apply their understanding to explain a related phenomenon (Elephant's Toothpaste). Students watch a video of the elephant's toothpaste reaction, analyze the change in mass before and after the reaction, and construct an argument to explain why the mass changes and identify possible gases produced from the reaction.
- Lesson 14: This lesson includes a three-dimensional summative task based on the interaction between different substances in the environment around the Taj Mahal and the marble surface of the monument to determine if a chemical reaction is occurring. The item alignment guide

provides a clear visual to see how each item is aligned with which SEP, DCI, and/or CCC. Each item is at least two-dimensional.

- Examples of multiple modality includes written, oral, and drawing/modeling. For example:
    - Lesson 2: Students develop a written argument for "where is the gas coming from?"
    - Lesson 5: Students present their oral argument on "What gas(es) could be coming from the bath bomb?" in small groups and receive feedback from their peers.
    - Lesson 7: Students individually revise their initial model by adding matter that goes into and out of the bath bomb system at a particle level.

Throughout the unit, opportunities for assessing three-dimensional learning goals are called out and they include "What to look for/listen for" and "What to do" sections. For example:

- Lesson 2: Construct and present an oral and written argument supported by empirical evidence and scientific reasoning to support the claim that gas is not trapped in the bath bomb to start with but must come from some change to the matter that was already in the system to begin with.
    - **What to look for/listen for**: Look for the use of key model ideas, for example that gas is matter so it has mass and takes up space. Look for the use of observations as evidence, such as: the mass of the bath bomb and water did not change in the closed system, the mass did not change before and after crushing, and the bag did not inflate after crushing. Making connections between the evidence and relevant key model ideas is the challenging part of providing coherent reasoning, so look for that logic as well. For example, "The gas must come from something that is already there--it is not new matter. We know that it came from something already there because…" Key: Sample Student Response for Written Argument is also available for your reference.
    - **What to do:** Collect the written arguments and identify where students are using evidence (underline it) and key model ideas (highlight them). Students will benefit from seeing multiple examples of where this support is being used in their own writing or in the writing of their peers (Teacher Edition, page 75).
- Lesson 8: "Ask questions related to the development of alternate models for what is happening to the matter at a particle level (patterns) when old substances interact to produce new substances by combining or rearranging parts/particles (systems and system models), and determine ways we might go about investigating these ideas.
    - **What to look for:** Students preparing to engage in the reading by recording the individual questions they have before starting it, in their individual Progress Trackers. Annotating the reading as they read or after a second pass. Recording what they feel they have figured out from the reading in their individual Progress Trackers.
    - **What to do**: Though we expect that given an opportunity to create individual questions many of these questions students generate will be in the space of "can particles of a new substance be formed out of the particles of an old substance in the ways we've come up with?", you might find some students develop a different line of questions. That is OK. As a reminder, individual Progress Trackers are not an assessment to be graded. The purpose instead is as a space for students to organize their thoughts. Here we want students to have that space before they go into the reading so that the purpose of it is student-question driven" (Teacher Edition, page 174).

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: Extensive

*(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because the Teacher Edition includes explicit, frequent, and varied support for formative assessment processes and attends to equity by providing support for different learners.

The unit contains a wide variety of formative assessment opportunities built directly into instructional sequences. For example:

- The Progress Tracker can be used to keep track of monitor student learning throughout the unit. It is suggested that teachers can use the tracker to formatively assess individual student progress, but it should not be graded.
- The Assessment System Overview provides a detailed outline of the purpose of each assessment in the unit. It is especially helpful that the Assessment Opportunity call out box is embedded throughout the Teacher Edition so the teacher knows where formative assessment occurs in the lesson.
- Exit Tickets are recommended. "This exit ticket structure is one you should use often, even if we do not specifically call out this structure. The student responses to these questions will allow you to assess students' sense of coherence in the science content storyline, their curiosity, and how they are working with other classmates' ideas in their learning community. Since this is an individual task, it will give you a good measure of this from each student. Additionally, this structure will communicate to your students that you value what they think and wonder about related to the science ideas you are focusing on in the unit." In Lesson 3, "Complete an exit ticket. Say to students, Use a note card or scrap of paper to answer the questions on the slide before you leave. The questions for students are: 1. What else should we investigate about these substances or try to do using these substances? 2. What is one new question you have based on the investigation we did today? 3. What was one new idea you heard from a classmate?" (Teacher Edition, page 95). In Lesson 14, "Have them record their ideas on an exit ticket. What was most rewarding in this unit? What was most challenging? What might you want to do differently the next time you engage in making sense of phenomenon in your next unit of study?" (Teacher Edition, page 264).
- Lesson 1: "Since students will put their initials on the backs of these sticky notes, you will have a few opportunities to take stock of the kinds of questions students ask in this initial lesson after they are posted on the DQB, as well as now when they write them. When students share these

questions for the DQB, they will likely only have time to share one. Collect the remaining questions that don't get posted after the development of the DQB is complete. This record of questions they form today will help you formatively assess their fluency in the practice at the start of this year. If your students are asking mostly closed questions, you can provide a copy of a photo of the questions on the Driving Question Board, and ask them to work on refining three or more of these questions so that they become 'how' and 'why' questions that can help answer the original question posted as well the original yes/no question" (Teacher Edition, page 44).
- Lesson 2: "Direct students to work individually to write an answer to the lesson question in the form of a well-supported argument. Have them use a new page of looseleaf notebook paper so you can collect their work as a formative assessment. They will make a claim, support their claim with evidence, and provide reasoning to connect their claim with any relevant key model ideas to show why their evidence supports their claim" (Teacher Edition, page 75).

In addition, the assessment provides guidance to teachers in regard to how to interpret a range of student responses and change instruction based on varied student responses. For example:
- Lesson 2: After students write an argument about where the gas comes from, the teacher collects the written argument to identify whether students have appropriate evidence and key model ideas. The teacher provides guidance to students who struggle with reasoning by showing them multiple examples or use the Key Model Ideas poster to help students identify ideas they can use to elaborate their claim (Teacher Edition, page 75).
- Lesson 3: Many formative assessments opportunities are embedded in the class discussion. For example, "If the class attempts to place a characteristic into the wrong grouping then push on students' thinking by asking questions or having students attempt to change some of the bath bomb properties. For example, if students think that texture is a property that can't be changed, have students attempt to grind Epsom salt (a coarse solid) into a powder" (Teacher Edition, page 93).
- Lesson 4: "If students are struggling to connect their arguments to the patterns in the data, refer back to the whole-class data chart (slide L) and/or the lemonade mix ingredient lists to ask, What similarities can we find here? If students are struggling to support their claims with evidence and reasoning, you may choose to record the argument as shared writing as the class composes it, and then underline evidence and highlight key model ideas as you did in Lesson 2" (Teacher Edition, page 111).
- Lesson 5: "For students who struggle with writing this argument, you could provide them with anonymized copies of a couple of exemplar student responses for them to annotate. Ask them to circle the claim, underline the evidence, and highlight the use of key model ideas in both. Ideally provide them two arguments that have different structure and different flow in how all of this is sequenced and connected together" (Teacher Edition, page 139).
- Lesson 6: "For students who need additional scaffolding for the written argument, use Alternate: Explaining another phenomenon that has sentence starters and other supports for students" (Teacher Edition, page 146).
- Lesson 9 Scoring Guidance: If students are struggling with developing their reasoning, provide them with additional practice by giving them copies of two different anonymized examples of strong arguments that were developed by students in other classes. For each of the two

arguments, ask students to underline the evidence provided and highlight instances of the incorporation of scientific principles" (Teacher Edition, page 302).

The formative assessments also attend to issues of student equity and provide support for modifying instructional activities to be more culturally responsive in addition to supporting student thinking toward learning goals. For example:

- Lesson 3: "Encourage students to express what they've learned using a mode that makes sense for them. For some emergent multilingual students, encourage them to use space to make sense in the language that they feel most comfortable using" (Teacher Edition, page 94).
- Lesson 5: "Universal Design for Learning: This discussion is one of many different ways students will express their understanding of types and forms of arguments they can make using property data related to gases. Other forms of expression in this lesson include: annotating Some Common Gases, predicting and discussing the results of first-hand investigations as they write a predictive explanation using sentence scaffolds, verbally sharing their conclusions using a discussion protocol, snapping their fingers and lightly tapping their feet in response to oral arguments, and writing a final argument. Providing students varied and multiple ways to express their understanding helps support them in accessing, building, and ultimately internalizing the strategies used in arguing from evidence in general, and not just for this specific case and context" (Teacher Edition, page 125).

Suggestions for Improvement

N/A

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

## Rating for Criterion III.C. Scoring Guidance: Adequate

*(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions because assessment targets for all dimensions being assessed are clearly stated and incorporated into scoring guidance and exemplar student responses are included.

The Teacher Edition specifically calls out assessment targets for all dimensions being assessed in the "Assessment Opportunity" Boxes. These boxes contain guidance as to what to look/listen for and what to do. For example:

- Lesson 9: Use mathematical and computational thinking by graphing mass vs. volume data for different substances and finding the ratio of mass to volume (a unit rate) [scale, proportion, quantity] for the samples measured to determine the density of different clear liquids.

- **What to look for**: Small group work determining mean (average) densities across samples from multiple groups that yields: close to 1.0 g/mL for water, close to 0.78 g/mL for rubbing alcohol, and close to 1.26 g/mL for glycerin. Though some classes may have results that are within a range of +/- 0.1 g/mL of these values, students in any single class should all find the same relationship between values using data from their particular class.
- **What to do:** If students struggle with finding or using unit rates in the context of density or averages you could: Provide additional measurements of water or alcohol for students to practice determining unit rates. Coordinate with the grade level mathematics teacher to provide other examples and practice finding unit rates students have been working with (or will be working with) in mathematics class (Teacher Edition, page 187).

Sample Student Responses are provided for key assessments throughout the unit. Scoring guide is found at the end of the Teacher Edition under “Lesson-Specific Teacher Materials” (Lessons 2, 5, 6, 9, 10, 12, and 14). The following are strong examples of guidance provided to teachers on how to interpret student progress:

- Lesson 2: “Key: Sample Student Response for Written Argument” is provided. The document outlines what to look for in student responses and provides suggestions for feedback. “You may find it helpful when providing feedback to your students to underline their evidence and highlight the key model ideas they use. An example student response with this coding is shown below” (Teacher Edition, page 285).
- Lesson 5: “Elements to look for in students’ written arguments” is provided. This document provides information as to what to look for in relation to CCCs and SEPs. For example: “CCC (Patterns): In their reasoning, students will be engaging in using the crosscutting concept of patterns in property data. For example, students should use the reasoning that the gas from the bath bomb is one of the non-flammable ones in the common gas properties table because the gas they tested extinguishes a flame” (Teacher Edition, page 291).
- Lesson 9: “Scoring Guidance: Evaluating and improving alternate arguments” is provided. In addition to outlining what to look for, the following guidance is provided: “What to do: If students are struggling with developing their reasoning, provide them with additional practice by giving them copies of two different anonymized examples of strong arguments that were developed by students in other classes. For each of the two arguments, ask students to underline the evidence provided and highlight instances of the incorporation of scientific principles” (Teacher Edition, page 303).

While a sample student response and keys are provided, no specific scoring guidance in the form of a rubric is available for specific assessment tasks.

Suggestions for Improvement

- Consider using a rubric with clear guidance for teachers to evaluate assessment targets. Include a range of student responses and interpretation guidance to support score interpretation.
- In addition to sample student responses, rubrics showing growth towards proficiency

expectations in each of the dimensions would be helpful for the teacher and student.

- Consider putting the "Lesson-Specific Teacher Materials" right after the lesson instead of at the end of the Teacher Edition to make it easier to find the scoring guide.

**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 the materials use developmentally appropriate text, provide tasks that do not assume all students know culturally-specific knowledge, and use a variety of modalities to collect information from students.

The following examples are evidence of this criterion:

- Vocabulary used throughout the unit is appropriate. The use of a Word Wall provides support for students who may struggle with vocabulary. "It is especially important for emergent multilingual students to have a reference for this important vocabulary, which includes an accessible definition and visual support" (Teacher Edition, page 22).
- Throughout the lesson, students are provided with opportunities to express their own ideas and bring their experiences to the rest of the class: For example, in Lesson 1, students are provided with an opportunity to discuss their prior experiences with Bath Bombs, experience one firsthand, and brainstorm related phenomena.
- The use of norms in the classroom ensures that students have a safe environment for sharing these ideas. Norms are established in Lesson 1. "It is important to use this norm building time to begin to cultivate an equitable learning community that promotes trusting and caring relationships. The norms should reinforce the value of diversity of the classroom community members, and equity in the sense-making work they will do together this school year. It is critical that the norms support safe and fair participation and interrupt cultural norms or stereotypes that could make science experiences feel uncomfortable to students (e.g., as being someone who is not intelligent enough to think like a scientist, who has trouble putting their thinking into writing, who cannot do the relevant math, or who cannot share their thinking)" (Teacher Edition, page 38).
- The student handouts which are provided are grade appropriate and accessible for all students. Alternative options are also provided. For example:
    - Lesson 5: In the Attending to Equity section, teachers are advised to "in addition to demonstrating the tests in real time, consider providing students access to the alternate videos of the investigations for students to re-watch or return to. These videos provide an additional option for representation that can help support students in processing the

information and can be slowed down or re-watched as needed" (Teacher Edition, page 126).

- For many assessments, multiple handouts are available which can be used for students who require different levels of support. For example, in Lesson 5, there are alternate handouts available for "My Predictive Explanations for the Gas from a Bath Bomb."
- In addition, students are provided with opportunities to express their thinking in a variety of ways, including written arguments and drawings. For example:
    - Lesson 1: Students construct a drawing to demonstrate what they believe is happening with the Bath Bomb.
    - Lesson 2: Students write an argument about where they believe the gas is coming from.
    - Lesson 4: Students engage in a discussion to argue which substances in a gas bomb produce a gas and if the gas is a new substance.
    - Lesson 14: Students can choose whether to complete Part 2a (explain marble changes) or Part 2b (explain iron changes).

However, while multiple modalities are provided for students to express their understanding, there is not a great deal of student choice involved in the modality which students utilize.

Suggestions for Improvement

- Consider providing increased flexibility in the modalities students utilize to convey their understandings which allow for student choice.
- In Lesson 5, the Where are We Going section informs teachers that "Students should be able to draw on their experiences with helium balloons and experiences with thinking about how the particle density of air changes with temperature in the OpenSciEd Unit 6.3: Why does a lot of hail, rain, or snow fall at some times and not others? (Storms Unit), to reason whether helium will float or sink in air and how the reported density value for it in grams per mL (compared to air) is related to those predictions" (Teacher Edition, page 122). While this could be beneficial for students who experienced this unit in grade 6, consider an alternative experience for students who did not experience it.
- Avoid using words with alternative meanings in sentence prompts or explain the terms to the students. These can be confusing for English Language Learners. For example: In Lesson 6, "Say, *Cool*, it sounds like we have figured out some things, but we still have more work to do! Tell students to tape this handout of DQB" (Teacher Edition, page 147). In Lesson 7, "Begin by saying, Let's *recap* and *take stock* of what we have figured out and what questions we still have about our bath bombs in relation to our Driving Question" (Teacher Edition, page 153).

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| **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

# Bath Bombs: How Can We Make Something New That Was Not There Before?

## EQuIP Rubric for Science Evaluation

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning because the assessment system is constructed to assess three-dimensional learning tasks through a variety of measures and types of assessments.

Assessments are mapped to three-dimensional learning goals for each unit, as evidenced in the Lesson-By-Lesson Assessment Opportunities provided in the Teacher Edition, which is described below:

- "The table below summarizes opportunities in each lesson for assessing every lesson-level performance expectation (LLPE). Examples of these opportunities include student handouts, home learning assignments, progress trackers, or student discussions. Most LLPEs are recommended as potential formative assessments. 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" (Teacher Edition, page 270).

The Teacher Edition contains an Assessment System Overview document which outlines the types of assessments in each unit which utilize a variety of measures. For example:

- Pre-Assessments
    - Lesson 1: "The student work in Lesson 1 available for assessment should be considered a pre-assessment. It is an opportunity to learn where students are coming in and what ideas they have that you can build on in this unit. The more ideas in your classroom the better. Specifically, look for students' initial understandings of modeling, asking questions, patterns, cause and effect, and matter and energy. Collect students' initial models on What Happens to a Bath Bomb When Put in Water? and Initial Model-based Explanation at the end of day 1 to pre-assess their fluency in three-dimensional learning. Look for students to include both macroscopic and microscopic elements in their initial models of the bath bomb. See the related Assessment callout box in the teacher guide for additional guidance. The Driving Question Board is another opportunity for pre-assessment. Listen for questions that are open (how/why) and testable versus closed (yes/no) in the classroom. Also listen for questions that are specific to the bath bomb and questions that are about related phenomena when solids are added to liquids. See the related Assessment callout box in the teacher guide for additional guidance" (Teacher Edition, page 268).
- Formative Assessments
    - Lesson 2: "In Lesson 2 students construct their first written argument with scaffolding. This serves as a formative assessment for where students are in their development of this practice. Look for the use of key model ideas and observations as evidence in their responses. See Key: Sample Student Response for Written Argument and the related Assessment callout box for additional guidance" (Teacher Edition, page 268).
    - Lesson 5: "Check students responses on My Predictive Explanations for the Gas from a Bath Bomb at the end of day 1 and provide feedback. See assessment guidance box in the teacher guide at the end of day 1" (Teacher Edition, page 268).

- Lesson 13: "Students develop an explanation for what an odor is and how it is detected after conducting an investigation and reading some informational text. They do this in their notebook. Since this is only the 2nd time in the OpenSciEd scope and sequence that students will have gathered and synthesize information that sensory receptors respond to stimuli by sending messages to the brain, and students will still have two additional experiences with this related NGSS PE: MS-LS1-8 in later 8th grade units: OpenSciEd Unit 8.1: Why do things sometimes get damaged when they hit each other? (Collisions Unit) and OpenSciEd Unit 8.2: How can a sound make something move? (Sound Unit) it is recommended that you use this as a formative assessment" (Teacher Edition, page 269).
- "The Progress Tracker is a thinking tool that was designed to help students keep track of important discoveries that the class makes while investigating phenomena and figure out how to prioritize and use those discoveries to develop a model to explain phenomena. It is important that what the students write in the Progress Tracker reflects their own thinking at that particular moment in time. In this way, the Progress Tracker can be used to formatively assess individual student progress or for students to assess their own understanding throughout the unit. Because the Progress Tracker is meant to be a thinking tool for kids, we strongly suggest it is not collected for a summative grade other than for completion" (Teacher Edition, page 270).

- Self-Assessments
  - Lesson 1: Students choose a focal norm to focus on during class discussion and reflect on their norms at the end of the lesson. This process allows students to self-monitor their behavior and contribution (Lesson 1, Slide K).
  - Lesson 4: Students reflect on their ability to follow norms and develop an argument through an exit slip (Lesson 4, Slide O).
  - Lesson 13: Students self-reflect and give non-verbal feedback on their confidence in planning and carrying out investigations to determine if a chemical reaction occurred, analyzing and interpreting data to support/refute an argument about whether a chemical reaction occurred, and using a molecular model to determine what substances could be produced. "This sort of informal survey of student readiness for the final assessment might also be useful to assign as an out of class assignment that students respond to before the next lesson, and then revisit again at the end of the next lesson (after the assessment). Such meta-cognitive reflections before and after a major assessment can help students develop a more accurate sense of what they know and can do over time." This shows how the teacher is supporting ongoing changes in student thinking (Teacher Edition, page 261).
- Summative assessment
  - Lessons 6 and 14 serve as summative tasks where students have to apply their understanding to other related phenomena (Elephant's Toothpaste and Marble Changes in the Taj Mahal).

Suggestions for Improvement
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

## Rating for Criterion III.F. Opportunity to learn: Extensive

The reviewers found extensive 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 there are multiple, linked student performances that provide students with several opportunities to demonstrate understanding. Teacher/students are engaged in multiple modalities of feedback in a timely fashion from teacher and peers. Students are provided opportunities to utilize feedback to construct new learning.

Throughout the unit, there are multiple interconnected opportunities for students to demonstrate understanding. Examples of these opportunities include:

- Students use the Progress Tracker throughout the unit to record ideas about what they have figured out.
- Lesson 7: Students take stock of what they have learned by reviewing the evidence they collected from Lessons 1–5. Students use this information to help them revise the class consensus model.

Within the unit, students are engaged in multiple modalities of feedback. Some examples of this include peer feedback through discussion. For example:

- Lesson 4: Building understanding discussion provides students with an opportunity to discuss their ideas with each other and get feedback from each other. "Asking students to restate what another student has said supports the goal of students listening carefully to each other so that they can work with others' ideas. This move can feel odd to students at first, so it will help if you let them know ahead of time that you will be asking this. It can also help to support this type of collaborative talk in the classroom to have sentence starters up on a bulletin board, or on a handout students could tape in their notebook and refer to" (Teacher Edition, page 111).
- Lessons 5 and 12: Students engage in small group discussion by following the Discussion Protocol. As each student shares their explanations, receives feedback from their peers, and comes to consensus about their claim with their classmates and/or use their peers' ideas to improve their models.
- Lesson 11: "If students are struggling with these ideas, they have an opportunity to compare their predictions and explanations with their small group at the start of the next lesson. Provide feedback to those students in the form of comments or notes that direct them to compare their responses to their peers and to resolve any differences" (Teacher Edition, page 225).

In addition, students receive direct feedback from the teacher based on their performance. For example:

- Lesson 3: “Monitor groups as they make observations. As students are making observations, visit each group and encourage students to be detailed in their observations. When needed, prompt students to add more detail so they can tell the ingredients apart” (Teacher Edition, page 84).
- Lesson 4: “Focus on providing feedback to students to help them articulate a logical flow in their thinking while also making the key pieces of the argument visible rather than simply implied” (Teacher Edition, page 112).
- Lesson 6: “ Use Elements to look for in students’ written arguments for guidance on what to look for in their written argument. Use this guidance to provide feedback to students on their written arguments” (Teacher Edition, page 274).

Throughout the lesson students are provided with opportunities to reflect on their learning. For example:

- Lesson 2: Exit Ticket: “Since this is students' first chance this year to write a strong and convincing argument, take a moment to ask them how confident they feel about this practice. Use slide Y to present the question, On a scale of 4 (totally independent) to 1 (need lots of help with this), how are you feeling right now about writing a well-supported argument? Briefly explain what makes you feel that way and what help you could use as you develop this practice. Direct students to respond on the bottom or back of the page where they wrote their argument. Students will have another chance to reflect on their confidence with argumentation in Lesson 5 so you and they can consider their progress with this practice” (Teacher Edition, page 75).
- Lesson 4: “Take a couple of minutes and individually reflect on where you feel you are in your ability to develop evidence-based arguments. Use the questions on the slide to guide you. The second question on the slide has to do with our norms. Reflect on the norm “Respectful” and explain how this norm helps us to be able to collaborate as we developed this argument together” (Teacher Edition, page 114).

Suggestions for Improvement

- Consider including opportunities for students to express learning claimed with choice of modality.

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

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

# Overall Score

**Category I: NGSS 3D Design Score (0, 1, 2, 3):** 2
**Category II: NGSS Instructional Supports Score (0, 1, 2, 3):** 3

# Bath Bombs: How Can We Make Something New That Was Not There Before?

## EQuIP Rubric for Science Evaluation

**Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3):** 3
**Total Score:** 8
**Overall Score (E, E/I, R, N):** E

| Scoring Guides for Each Category |
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| **Unit Scoring Guide** |
| **Category I (Criteria A-F):**<br>**3:** At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C<br>**2:** At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C<br>**1:** Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C<br>**0:** Inadequate (or no) evidence to meet any criteria in Category I (A–F) |
| **Category II (Criteria A-G):**<br>**3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria<br>**2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A<br>**1:** Adequate evidence for at least three criteria in the category<br>**0:** Adequate evidence for no more than two criteria in the category |
| **Category III (Criteria A–F):**<br>**3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion<br>**2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A<br>**1**: Adequate evidence for at least three criteria in the category<br>**0**: Adequate evidence for no more than two criteria in the category |

| Overall Scoring Guide |
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| ***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)* |