Interactions Unit 2
EQuIP Rubric for Science Evaluation

Unit Name: Interactions Unit 2
Grade: 9, 10
Date of Review: September 2018
Overall Rating (N, R, E/I, E): E/I
Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 2
Total Score (0-9): 7
Click here to see scoring guidelines

This review was conducted by the Science Peer Review Panel using the EQuIP Rubric for Science.

Category I Criteria Ratings		Category II Criteria Ratings		Category III Criteria Ratings	
A. Explaining Phenomena/Designing Solutions	Extensive	**A. Relevance and Authenticity**	Adequate	**A. Monitoring 3D Student Performances**	Extensive
B. Three Dimensions	Extensive	**B. Student Ideas**	Adequate	**B. Formative**	Adequate
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**	Inadequate	**E. Coherence Assessment System**	Inadequate
F. Math and ELA	Adequate	**F. Teacher Support for Unit Coherence**	Extensive	**F. Opportunity to Learn**	Adequate
		G. Scaffolded Differentiation Over Time	Inadequate		

Summary Comments

The development of the three dimensions in this unit provides students an opportunity to make sense of the world around them, which is what the NGSS are all about. The structure of the teacher materials makes it abundantly clear how to integrate the three dimensions. The unit includes an engaging and thought-provoking phenomenon able to drive the instruction for the entire unit. The variety of activities and investigations provides students with a path to learning that stimulates interest in the content presented. While a model example of three-dimensional learning, this unit falls short in the EQuIP rating due to some inadequate unit criteria such as relevance, differentiation and assessment. These areas could easily be addressed or included in the unit to move this submission to a higher rating.

Category I. NGSS 3D Design

Score: 3

I.A. Explaining Phenomena/Designing Solutions: Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.
ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.
iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

Rating for Criterion I.A Explaining Phenomena/Designing Solutions: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that learning is driven by students making sense of phenomena and/or designing solutions to a problem because students engage in a series of lessons in order to make sense of the anchoring phenomenon: a small spark triggering a huge explosion.

In doing so, they also explore a number of lesson-level driving questions related to phenomena such as:

- "How does potential energy change when things are pushed or pulled?"
- "Where does the energy that was used to charge the Van De Graff generator go?"
- "Why is lightning so much bigger than a spark from the Van de Graff generator?"
- "Why do I get shocked if I am close to the Van de Graff generator?"

This anchoring phenomenon is rich enough to drive the learning throughout the unit and elicit a range of investigable questions related to phenomena over the course of the unit.

Suggestions for Improvement

To help teachers who are familiar with the importance of phenomena but may not be sure what it looks like in materials, it would be helpful to have a visual cue (text color, highlighting, etc.) and/or consistent language in the teacher materials to call out the phenomena that students are figuring out in a given activity. As written, an experienced teacher will see the phenomena, but a novice teacher may not.

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: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions.

Science and Engineering Practices (SEPs): Extensive

This unit contains numerous opportunities for students to develop and use elements of the SEPs. All the activities are at the grade-appropriate level for a high school student and aid in student sense-making of the anchoring and lesson-level phenomena. Here are several examples:

Activity 1.2, page 24 – "Write a complete scientific explanation to account for why the heavier ball caused more flour to spread out. Be sure to include the relationship between the amount of mass and amount of kinetic energy in your explanation, and include a claim, evidence and reasoning.

Constructing Explanations and Designing Solutions

- *Grade 9-12 Element: Make a quantitative and/or qualitative claim regarding the relationship between dependent and independent variables.*

Activity 2.1, page 18 – "Based on the snapshots you took for the previous questions, make a stacked bar graph of the energy before, during and after the simulation ran."

Using Mathematics and Computational Thinking

- *Grade 9-12 Element: Use mathematical, computational and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*

Activity 3.2, page 36 – "Predict how two atoms will interact as they come close to each other. Support your prediction based on your model of electric forces and your model of atoms."

Developing and Using Models

- *Grade 9-12 Element: Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*

The reviewers did not find any examples of SEPs that were claimed to be addressed in an activity that were not supported by evidence in the materials.

Disciplinary Core Ideas (DCIs): Extensive

Numerous examples of opportunities for students to develop and use elements of the DCIs exist in this unit. Some of the identified Performance Expectations (PEs) are from Middle School. These are intentionally added to bring students up to speed and do not detract from the ample opportunities for students to make sense of phenomena at a grade-appropriate level.

Middle School PEs: In the following cases, these PEs are intentionally selected to bring in below grade-level DCIs to ensure students are prepared for more conceptually challenging high school PEs.

- Investigation 1, page 2: MS-PS3-5
    - DCI: **PS3.B: Conservation of Energy and Energy Transfer**; *Element: When the motion energy of an object changes, there is inevitably some other change in energy at the same time.*
- Investigation 2, page 2: MS-PS3-2
    - DCI: **PS3.A: Definitions of Energy**; *Element: A system of object may also contain stored (potential) energy, depending on their relative positions.*
    - DCI: **PS3.C: Relationship Between Energy and Forces**; *Element: When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.*
- Investigation 3, page 2: MS-PS1-1
    - DCI: **PS1.A: Structure and Properties of Matter**; *Elements: Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms; Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals).*

PS3.B: Conservation of Energy and Energy Transfer

Investigation 1: At the conclusion of this lesson, students answer the following questions to build towards PS3.B: What forms of energy are present in these examples? What does it mean that energy is conserved? and How is energy conserved in these examples?

Grade 9-12 Elements:

- *Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.*
- *Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.*

PS3.C: Relationship Between Energy and Forces

Investigation 2: Students build on their models of electric interactions to relate electric force and electric potential energy to explain sparks. This is building towards HS-PS3-5.

Grade 9-12 element:

- *When two objects interacting through a field change relative position, the energy stored in the field is changed.*

PS1.B: Chemical Reactions

Investigation 3: Students explore simulations and build models to explain why separate atoms form a molecule and the energy transfer and conversion that occurs when a molecule forms and breaks. This is building towards HS-PS1-4.

Grade 9-12 element:

- *Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy.*

PS3.A: Definitions of Energy and **PS1.B: Chemical Reactions**

Investigation 4: Students track energy throughout the system of a chemical reaction and classify reactions as endothermic or exothermic. This is building towards HS-PS1-4, HS PS1-5 and HS PS3-2.

Grade 9-12 elements:

- *Chemical processes, their rates, and whether or not energy is stored or released can be understood in terms of the collisions of molecules and the rearrangements of atoms into new molecules, with consequent changes in the sum of all bond energies in the set of molecules that are matched by changes in kinetic energy. (PS3.A)*
- *Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system energy is continually transferred from one object to another and between its various possible forms. (PS1.B)*

The reviewers did not find any examples of DCIs that were claimed to be addressed in an activity that were not supported by evidence in the materials.

Crosscutting Concepts (CCCs): Extensive

Numerous examples of opportunities for students to develop and use elements of the CCCs exist in this unit. All the activities are at the grade-appropriate level for a high school student and aid in student sense-making of the anchoring and lesson-level phenomena.

Cause and Effect

Activity 1.1, page 16 – "Draw an initial model to explain how the spark from a Van de Graff generator lit the Bunsen burner."

Grade 9-12 Element:

- *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*

Energy and Matter

Activity 1.2, page 35 – "When the tennis ball and basketball are bounced together, why does the tennis ball bounce so high and the basketball bounce so low? Be sure to include the ideas of energy transfer and energy conservation that you developed in this activity."

Grade 9-12 Element:

- *The total amount of energy and matter in closed systems is conserved.*
- *Energy cannot be created or destroyed-it only moves between one place and another place, between objects and/or fields, or between systems.*

Systems and System Models

Activity 2.2, page 26 – "When you push repelling magnets together, is there potential energy in the system? If so, where? If not, what happens to the energy used to push the magnets together?"

Grade 9-12 Element:

- *Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions – including energy, matter, and information flows – within and between systems at different scales.*

Patterns

Activity 3.3, page 54 – "Using the simulation, find a pattern in how the potential energy of the system changes when the relative distance between two atoms changes. Describe the pattern.

Grade 9-12 Element:

- *Empirical evidence is needed to identify patterns.*

The reviewers did not find any examples of CCCs that were claimed to be addressed in an activity that were not supported by evidence in the materials.

Suggestions for Improvement
N/A

I.C. Integrating the Three Dimensions: Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

Rating for Criterion I.C. Integrating the Three Dimensions: Extensive

(None, Inadequate, Adequate, Extensive)

The three dimensions are inextricably linked in this unit. Every activity describes a Learning Goal that is three-dimensional. The DCI, SEP, and CCC for each activity is clearly indicated. Almost every investigation is structured so that students are utilizing an element of a practice to figure out the activity-level phenomenon while question prompts help students use the CCCs at the element level to think about their observations. For example,

- In Activity 1.2, teachers are provided an example discussion of how to help students develop an accounting system for energy changes, defining the system, and utilizing patterns from their observations during a simulation about energy changes during collisions of spheres. Then, students are asked to apply this to a new simulation and ultimately compare models to explain using patterns in their data.
- In Activity 2.1, "Students analyze and interpret data (SEP) to define the cause-and-effect relationship (CCC) between force (DCI) and changes (CCC) in potential energy (DCI). Applying a force to move something from a stable state (CCC) increases (CCC) the potential energy of the system (CCC)."

Suggestions for Improvement
N/A

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

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.
ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

Rating for Criterion I.D. Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

There is extensive evidence of quality for the unit coherence in this submission. Explicit instructions are provided referencing learning from a previous unit or learning from a previous activity within the unit. Each lesson is purposeful in the piece of the puzzle needed to construct an explanation for the phenomenon and the activities are tightly tied to elements of the targeted PEs. For example,

- Driving Questions (DQs): DQs are used for each Investigation and Activity. These questions are continually refined and revisited throughout the progression of activities. At the end of each investigation, the DQ is addressed one final time before moving to the next investigation.
- Activity 1.1 revisits Unit 1, Investigation 1 to prompt students' thinking about how a Van de Graff generator works and to use the model of charge that they developed in that unit. The limitations of that model are used to create a need for more exploration. Throughout the unit, students are prompted to revise their model utilizing new learning and revisit the driving question to consider what they can add to their explanation.

Suggestions for Improvement
It would be nice in the unit overview to have a map or a description of what the students are figuring out in each activity and how it ties to the three dimensions and to the anchoring phenomenon.

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

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.
ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

Rating for Criterion I.E. Multiple Science Domains: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that links are made across the science domains. Concepts typically addressed in a physics class (force, motion, energy, fields) are seamlessly tied to typical chemistry concepts (energy changes in a reaction, bond energy, molecular structure). Though these are technically both within the physical science domain, the reviewers recognize that they are often taught in isolation and have decided to recognize this connection as evidence for this criterion. There is some connection to Earth and space science concepts when students are provided an opportunity to make connections between the spark generated from the Van de Graaff to lightning (Activity 2.4).

The CCCs of Matter and Energy and Systems and System Models are the frames used for helping students connect forces, motion, and fields to reactions and bonding.

Suggestions for Improvement

The reviewers recognize that all units cannot do all things and it may not have been feasible to integrate multiple science domains in this unit without it feeling slightly forced. We also saw that, according to the overview, other units in this course do bring in other science domains (such as HS-LS1-6 in Unit 4), but to earn an extensive rating for this criterion, clear and obvious connections need to be made across science domains within the unit being reviewed.

For example, it may have worked to include specific reactions involving molecules associated with providing energy in living systems to further help students connect the fundamental science ideas at the molecular level to those necessary for life.

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

Rating for Criterion I.F. Math and ELA: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide grade-appropriate connections to mathematics and English language arts (ELA).

ELA

Students are assigned readings throughout the unit and probing questions are used to connect readings to classroom investigations. Students also complete Claims-Evidence-Reasoning (CER) writing.

- CCSS.ELA-LITERACY.RST.9-10.10
  By the end of grade 10, read and comprehend science/technical texts in the grades 9-10 text complexity band independently and proficiently.
- CCSS.ELA-LITERACY.WHST.9-10.1.B
  Develop claim(s) and counterclaims fairly, supplying data and evidence for each while pointing out the strengths and limitations of both claim(s) and counterclaims in a discipline-appropriate form and in a manner that anticipates the audience's knowledge level and concerns.

Math

Students must use data, especially from simulations, to examine energy exchanges with a focus on transfer, transformation, and conservation of energy.

- CCSS.MATH.PRACTICE.MP4 Model with mathematics.

Suggestions for Improvement

A greater range of types of reading as well as the use of other media may provide greater access to students and address the spirit of the CCSS for ELA.

Opportunities for students to draw conclusions by interpreting the algebraic structure of formulas (see Appendix L, page 28) could be added to strengthen the connection to mathematics.

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

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

Category II. NGSS Instructional Supports

Score: 2

II.A. Relevance and Authenticity: Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).
ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.
iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

Rating for Criterion II.A. Relevance and Authority: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world.

The unit phenomenon—the spark from a Van de Graff generator lighting a Bunsen Burner—is a common experience and supporting phenomena are experienced directly. Students engage in hands-on activities when possible. They also engage in computer simulations to make atomic-level interactions visible. While there are probing questions throughout the unit such as, "Have you ever noticed...", the reviewers did not, however, find explicit examples in the unit that prompted students to connect what is learned at school to life beyond school.

Suggestions for Improvement

Provide suggestions for tying the experiences and conclusions to students' home/community and/or culture. This could be done during the numerous opportunities provided for students to ask and refine questions. Include prompts for teachers to utilize that would help students relate observations to their own experiences and tie those to the DQ board.

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: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas. Each activity associated with the four investigations provides students a range of opportunities to make their thinking visible through models, explanations, and discussions. Explicit examples of look-fors are provided for teachers along with questions, which can be used for providing appropriate feedback, but are not clearly labeled for that use.

Opportunities for peer feedback are not explicitly described in the teacher materials.

Suggestions for Improvement

Provide some variety in the class discussions to elicit student ideas. There are several engagement, discourse, or science talk strategies that could be utilized. Novice teachers may not be aware of these and may need guidance.

Consider adding more opportunities for peer feedback when students create a model or explanation. Pointing out appropriate places for this to happen in the unit would strengthen the score for this category.

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

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

Rating for Criterion II.C. Building Progressions: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions. Teacher Preparation sections for each activity include a chart of the three dimensions, the elements, and an NGSS PE reference.

An Overview is provided at the beginning of each Investigation. The Overview addresses the previous learning and explains how the new investigation links to the previous activities. Summaries are provided at the beginning of each activity and reference the learning from the previous activity and how the current activity builds on that previous activity. Clear references to models or explanations built in the previous unit are made, limitations are identified, and clear explanations of how new observations will be used to develop are provided.

Suggestions for Improvement

Consider detailing how students are not only building on their previously developed models or explanations, but on how they are expanding their use of models, investigation design, data analysis and interpretation, and explanations throughout this unit. In addition, clear examples of how students are growing in their use of **Matter and Energy** and **Systems and System Models** would be helpful to teachers.

A clear map or description in the Overview of what students are expected to have when they come into this unit, how the learning in the unit builds each of the three dimensions, and where students should be for all three dimensions after the unit would move this to extensive.

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

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

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

Background knowledge sections are included in each overview to ensure teacher understanding of scientifically accurate information. "Point for Consideration" (e.g., Activity 3.3, page 49) section in some Activities guides teachers to understand the possible misconceptions and difficulties students may have with the lesson.

Suggestions for Improvement
N/A

II.E. Differentiated Instruction: Provides guidance for teachers to support differentiated instruction by including: i. 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. ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations. iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

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

The reviewers found inadequate evidence that the materials provide guidance for teachers to support differentiated instruction. Though it's clear from the pedagogical stance in the Overview and the careful way that the unit is structured that the intent is to create a learning environment that values all students learning, there is no specific guidance provided to teachers of alternatives for students with special needs, English learners, or students with high interest, which is an expectation of this criterion.

The "Points for Consideration" sections help teachers identify possible misconceptions and difficult concepts for struggling learners, but they are not specific to supporting differentiated instruction.

Suggestions for Improvement
More specific notes about accommodating marginalized learners and addressing the needs of advanced learners would be helpful and appropriate.

Some could include:

- modified handouts;
- graphic organizers for writing;

- word banks;
- sentence frames;
- sentence stems;
- leveled articles for different readers; and/or
- alternative assignments.

Include extension opportunities for students who have met either the PEs or the lesson-level learning targets. The addition of more rigorous data representation and analysis could be included. A range of more sophisticated reading materials could be provided.

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

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).
ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

Rating for Criterion II.F. Teacher Support for Unit Coherence: Extensive

(None, Inadequate, Adequate, Extensive)

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time.

Strategies provided to teachers to support unit coherence are pervasive and ensure student sense-making and engagement. Each investigation includes an overview of the lesson, connection to PEs, elements of the NGSS, student targets, and background knowledge. Each activity includes a summary of the activity, a learning goal with clarification, points for consideration, and notes that contain what students are and are not expected to provide.

DQs are used for each Investigation and Activity. These questions are continually refined and revisited throughout the progression of activities. Opportunities are provided for students to add questions as they arise and to connect to future learning or phenomenon. At the end of each investigation, the DQ is addressed one final time before moving to the next investigation.

Suggestions for Improvement

As was mentioned in Category I, Criterion D, it would make the evidence for this criterion clearer if the materials included a map or description in the unit overview of what the students are figuring out in each activity and how it ties to the three dimensions and to the anchoring phenomenon.

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: Inadequate

(None, Inadequate, Adequate, Extensive)

The reviewers found inadequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time because scaffolding support for students in this unit is implied but not explicitly addressed. Though there is a deeper explanation of the practices in a way that scaffolds teacher understanding in the Appendix, there are not strategies for scaffolding the learning of this practice for students.

There is a sequence to the lessons that builds progressively over the course of the unit. Questions and discussions become more complex and less formative and more summative.

Suggestions for Improvement

Provide specific examples for teachers to use to gradually adjust the amount of scaffolding over time. Call attention to these for the teacher in the in the lesson (e.g., "In the beginning of the lesson, students did XYZ …now students are expected to…").

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

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

Category III. Monitoring NGSS Student Progress

Score: 2

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

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

The reviewers found adequate 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. Each investigation engages students in three-dimensional sense-making. The construction of models and/or CERs allows for monitoring thinking and progress in each investigation. Teacher Preparation sections for each activity include a chart of the three-dimensions, the elements, and an NGSS reference. For example,

- In Activity 2.1, students are using a model of conservation of energy to describe and make predictions about mechanical processes. This activity combines the conservation of matter DCI, the CCC of Systems and System models while using the SEP of developing and using models.
- In Activity 3.3, students will use their conceptual model of atoms to explain, in terms of relative potential energy due to electric interactions, why a molecule forms. This activity combines the DCI of structures and properties of matter, the CCC of cause and effect while using the SEP of developing and using models.
- In Activity 4.4, students are asked to construct their "final" explanation to the driving question. The CCC of Matter and Energy is required in their explanation.

Suggestions for Improvement
To go above and beyond, consider providing additional transfer task ideas, which would require students to use their model explaining energy transfer and transformation at the molecular level (e.g., fertilizer plant explosions, "spontaneous combustion" of a sawdust pile, or a sugar plant explosion).

III.B. Formative: Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

Rating for Criterion III.B. Formative: Adequate
(None, Inadequate, Adequate, Extensive)

Formative assessment in the form of discussions, model sharing, probing questions, and model refinement occur regularly in this unit. The reviewers did not, however, see evidence of examples of how to adjust instruction based on the results of the formative assessments. For example,

- Activity 1.2, page 34: Review the model shown in the simulation by asking students to identify the components, relationships, and connection to phenomena.

- Activity 2.1, page 17: Referring to your *before*, *during* and *after* snapshots, explain what happens to the energy from the beginning to the end of the simulation.
- Activity 3.2, page 44: Using the simulation, explain how the electron density shift resulting from changing relative position of the atoms contributes to holding the two atoms together.

Suggestions for Improvement

Consider adding strategies for teachers to adjust instruction if, based on the formative assessments, students would need additional support or re-teaching.

This unit provides a wide variety and quantity of assessment opportunities, but it would be helpful to also identify what learning is critical to make sure students understand before moving on. Being more explicit about these key assessment items may better support the teacher.

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

Rating for Criterion III.C. Scoring Guidance: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that the include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions. The unit outlines clearly what verbal and written responses are desired from students and what each model should include. It advises where to give general feedback and avoid evaluation.

Student Response boxes are provided for each student activity. Boxes provide possible answers from students and suggested teacher responses to those answers, whether correct or incorrect answers. These can be used to plan and provide feedback; however, the reviewers did not see evidence of support materials that could be used for students to self-assess or provide peer feedback.

Suggestions for Improvement

This category would be rated extensive if the rubrics for the models and the CER writing pieces that are in the Appendix were specific to this unit in a way that helped teachers to evaluate the three-dimensional learning that is happening. This would also increase the ability of students to self and peer assess.

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. Materials in this unit explicitly identify indicators of conceptual understanding and relevant elements of SEPs and CCCs without an overemphasis on terminology. Phenomena and student activities are experienced first-hand and are therefore accessible.

Suggestions for Improvement

Written assignments may pose a problem for students with certain disabilities or language barriers. Consider allowing those students to answer orally. Some students may not be able to engage with the computer simulation due to certain disabilities. Consider providing an alternative task.

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: Inadequate

(None, Inadequate, Adequate, Extensive)

The reviewers found inadequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

- Explicit examples of pre-assessment are not evident, although some questions and the initial model could be used as such.
- Formative assessment opportunities are a strength in this unit and occur frequently. As discussed in Criterion III.B: Formative, this would be stronger if there was support for adjusting instruction based on student responses.
- The summative assessment consists of constructing an explanation to the driving question, which would not provide a teacher with information as to whether students understood how the science concepts apply to numerous phenomena.
- Opportunities for self-assessment are not made explicit.

Suggestions for Improvement

A formal pre-assessment could be added. Questions could be more clearly labeled as pre-, formative or summative and it would be useful for students to have checkpoints concerning their own understanding of the targeted DCIs, SEPs, and CCCs. Consider adding a more robust summative assessment that would require the transfer of knowledge to a new situation (e.g., fertilizer plant explosions, “spontaneous combustion” of sawdust pile, sugar plant explosion, etc.).

Support in the teacher materials that explain how the variety of assessments work together to give a picture of student learning over the course of the unit would help move this rating to adequate.

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: Adequate

(None, Inadequate, Adequate, Extensive)

The reviewers found adequate evidence that students are provided multiple pathways to demonstrate their knowledge of DCIs concurrently with the SEPs and CCCs. Each investigation includes simulations, models, experiments, data collection and opportunities to discuss, write and share their new learning. Opportunities for feedback are mostly implied.

For example, in Investigation 1, students observe a demonstration and ask questions. They experiment with spheres of different masses and use an online simulation to determine the relationship between speed, mass and kinetic energy and ultimately define conservation of energy. Using food coloring and water of different temperatures, students investigate the connections between changes in the speed of particle motion with changes in the temperature of a system. Students observe a demonstration and discuss types of energy. The investigation concludes with a pendulum simulation to solidify understanding of energy transfer.

Suggestions for Improvement

While these opportunities are implicit, it would be useful to include explicit opportunities for students to demonstrate understanding and receive feedback from peers and/or the teacher.

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

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

Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): 3
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 2
Total Score: 7
Overall Score (E, E/I, R, N): E/I

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

0: Inadequate (or no) evidence to meet any criteria in Category I (A–F)
Category II (Criteria A-G): **3:** At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria **2:** Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1:** Adequate evidence for at least three criteria in the category **0:** Adequate evidence for no more than two criteria in the category
Category III (Criteria A–F): **3**: At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion **2**: Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A **1**: Adequate evidence for at least three criteria in the category **0**: Adequate evidence for no more than two criteria in the category

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