P6: Stars and The Big Bang

DEVELOPER: OpenSciEd

GRADE: HS **|** **DATE OF REVIEW:** June 2024

Educators Evaluating Quality Instructional Products

NextGen Science WestEd

Stars and the Big Bang

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E

TOTAL SCORE: 8

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

Click here to see the scoring guidelines.

This review was conducted by NextGenScience's cadre of expert reviewers using the EQuIP Rubric for Science.

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

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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 has many strengths. For example, students are provided with multiple, varied opportunities to produce integrated three-dimensional artifacts of learning, they have multiple opportunities to express their ideas, and a coherent assessment system is clearly established and explained.

During revisions or use in the classroom, the reviewers recommend paying close attention to the following areas:

- **Opportunities for building understanding of grade-appropriate Disciplinary Core Ideas (DCIs)**. A large number of DCI elements are currently identified as learning targets. Consequently, students many not be able to engage with the DCI elements at the depth and breadth that is expected by the NGSS and the *Framework for K–12 Science Education*. Reducing the number of DCI learning targets would allow students to spend more time deeply engaging with the targeted elements.
- **Opportunities for building understanding of grade-appropriate Crosscutting Concepts (CCCs).** A large number of CCC elements are currently identified as learning targets. Providing students with opportunities to clearly use these elements could help them have greater access to the deep understanding of the CCCs that is expected by the NGSS and the *Framework for K–12 Science Education* and could help allow them to transfer those understandings throughout the learning sequence and to other real-world experiences.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met, and purple text is used as evidence that the criterion was not met.

Unless otherwise specified, page numbers in this document refer to the page numbers listed in the Teacher Edition PDF.

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

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

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

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

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

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

The reviewers found extensive evidence that learning is driven by students making sense of a phenomenon (a supernova event). Students' ideas and questions are consistently leveraged to drive the instruction throughout the unit.

An anchoring phenomenon drives sense-making throughout the unit. On page 8 of the Teacher Edition, the anchoring phenomenon is identified as "historical accounts of stars that suddenly appear and then disappear a short time later. Students wonder about how some stars appear unchanging, while these stars change so drastically within such a short period of time." Students consistently return to this phenomenon through a majority of the subsequent lessons. Additionally, their questions about stellar life cycles, cosmology changes over time, and the supernova (guest star) event drives sense-making throughout. Some related evidence includes:

- Lesson 1, step 1: Students are introduced to the "guest star" that appeared in the sky suddenly in the spring of 1054 AD. Students then work collaboratively to map the location of the "guest star." Students are provided with an opportunity to begin recording what they notice and wonder. These student-driven observations and questions are then shared with partners.
- Lesson 1, step 2: Students work collaboratively to read historical observations of "guest stars." As they do so, they continue to add to their "Notice and Wonder" chart.
- Lesson 1, step 5: Students are presented with a "Home Learning" assignment. Students are told, "As we saw in the historical record, people from across cultures have made rigorous observations and told valuable stories that are still helping us understand stars." While this assignment might support students as they learn about stars, it does not support their sense-making of the identified anchor phenomenon.
- Lesson 1, step 7: Students engage in a "mini lecture" in which the teacher tells them about a "guest star" event that occurred in 1987. Students are given an opportunity to record what they notice and wonder in their charts, which they began earlier in the lesson.

- Lesson 1, step 8: Students generate initial models to explain why some stars appear stable over time while others change dramatically. Students are encouraged to use the “matter (M) - energy (E) - forces (F)” thinking developed in previous units to support their modeling.
- Lesson 1, step 9: Guidance is provided for the teacher to lead the students in a “Scientists Circle,” in which they share ideas to generate a class consensus model of a typical star and a guest star.
- Lesson 2: Students analyze images of remnants of “guest stars” and the sun to begin comparing and contrasting stable stars and guest star remnants and are given opportunities to generate additional questions based on their observations. Students are introduced to and begin to use their Progress Tracker to keep a record of what they have figured out about the anchoring phenomena.
- Lesson 2, step 6: Students are asked to engage in a “Scientists Circle” activity in which they share their questions and add them to the Driving Question Board (DQB).
- Lesson 3, step 1: Provided teacher guidance makes explicit the connection between the purpose of the lesson and student’s previously surfaced ideas about energy transfer and matter transformation. Students are presented with two research questions and asked to identify questions on the DQB related to those questions.
- Lesson 3, step 7: Students have an opportunity to create initial models of a stable star and then work collaboratively to share ideas and generate a class consensus model. In step 8, students return to the DQB and their Progress Trackers to record what they have figured out about guest stars and stable stars.
- Lesson 4, step 2: Students return to the consensus model from the previous lesson and discuss forces within stars. Students continue to add to their model to include those forces, and guidance is provided that states, “Let’s start modeling a star when it is stable, so that we can use that model to make predictions about what could happen to make it no longer stable.”
- Lesson 5, step 1: Students revisit the related phenomena that they brainstormed in Lesson 1 to make connections with cause-effect feedback loops, stability, and change. In step 4, students work collaboratively to generate a “Feedback Loop” consensus model.
- Lesson 6, step 2: Students are presented with a lesson-level phenomenon: spectral data of stars, galaxies, and empty space. Guidance is provided that students will look at this spectral data for the purpose of generating questions that will “foster questions that will lead to a line of evidence that support the Big Bang Theory and how it explains the composition of the universe and how it changes over time.” This line of questioning supports the established purpose of the second lesson set as described on page 9. It marks a shift away from students figuring out the presented anchoring phenomenon but is still connected topically to the anchoring phenomenon.

Students have opportunities to ask questions that are used to motivate sense-making in the unit. Some examples include:

- Lesson 1, step 4: Students are given an opportunity to generate questions that they have developed as a result of their historical readings and discussions in their jigsaw groups. Guidance is provided that students will share these questions with the class if there is time and that they will use them when establishing the DQB.

- Lesson 1, step 10: Students work collaboratively to create a DQB. Students return to this DQB to add questions and identify which questions have been answered in Lessons 2, 3, 5, and 7.
- Lesson 2: Students analyze images of remnants of guest stars and the sun to begin comparing and contrasting stable stars and guest star remnants and are given opportunities to generate additional questions based on their observations.
- Lesson 4, step 3: After modeling the forces in a stable star, students are asked to brainstorm research questions and then choose a question that they wish to research.
- Lesson 6, step 2: Students generate questions about the presented spectral data from stars, galaxies, and empty space and are then provided opportunities to choose a question they wish to research for an answer.

Suggestions for Improvement

In Lesson 6, consider making the connection to the Big Bang Theory clearer for students. Although they are referring to the spectra used in Lesson 2, it may currently be very difficult for students to make those connections to the Big Bang Theory.

I.B. THREE DIMENSIONS

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

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

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

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

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

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Students have many opportunities to use the three dimensions. However, there is a significant mismatch between the elements claimed as learning targets and those that students are actually using in the unit.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the SEPs in this unit. While the materials provide opportunities for students to develop and use grade-level appropriate SEP elements, there is some mismatch between what is claimed and those actually used by students.

Asking Questions and Defining Problems

- *Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.*
    - Lesson 1: This element is claimed.
        - Step 2: Students read historical accounts of observations gathered from a "guest star" appearance. Students are instructed to "record some questions that have come up so far in their notebooks and be ready to share them with the class."
        - Step 7: Students engage in a "mini lecture" in which the teacher tells them about a "guest star" event that occurred in 1987. Students are instructed to record what they wonder in their science notebooks.
    - Lesson 2. This element is claimed. Students analyze images of remnants of "guest stars" and the sun to begin comparing and contrasting stable stars and guest star remnants. In step 6, they are asked to generate questions from these observations that will be added to the established DQB.
    - Lesson 4: This element is claimed. In step 3, after modeling the forces in a stable star, students are asked to reflect on questions that came up during the modeling activity and to brainstorm additional research questions that would "help us make progress on figuring out about what causes stars to remain stable or become unstable and change."
    - Lesson 7: This element is claimed. In step 2, students are given an opportunity to create a "Future Question Board" composed of any new questions they wish to investigate on their own. As they do so, students are most likely using experiences with the presented phenomena or research activities to generate these questions. However, there is no guidance provided to ensure that students are actually using observations of phenomena or the results of their investigations to craft these questions.
- *Ask questions to clarify and refine a model, an explanation, or an engineering problem.*
    - Lesson 1: This element is claimed. In step 9, students engage in a consensus modeling activity in which they model a "typical" star and a "guest star." During that process, guidance is provided to have students explicitly attend to matter, energy, and forces (M-E-F) interactions. In step 10, students are asked to develop questions for the DQB, and guidance is provided that states, "Tell students, 'we have been organizing our ideas in terms of matter, energy, and forces. Let's try organizing our DQB that way to make visible what kinds of questions we have about this phenomenon and help us figure out where we want to go first.'"
    - Lesson 4: This element is claimed. In step 3, after modeling the forces in a stable star, students are asked to reflect on questions that arose during the modeling activity and to brainstorm additional research questions that would "help us make progress on figuring out about what causes stars to remain stable or become unstable and change."

Developing and Using Models

- *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.*
    - Lesson 1: This element is claimed. In step 9, students engage in a consensus modeling activity in which they model a "typical" star and a "guest star." As they do so, specific guidance is provided that states, "What was one component both you and your partner included in your model of a stable star system?" Additionally, guidance is provided to have students explicitly attend to matter, energy, and forces (M-E-F) interactions. Students are beginning to illustrate relationships between components of a system.
    - Lesson 5: This element is claimed. In step 3, students are asked to "develop a series of models to tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." Students are encouraged to use their "Gotta Have It" checklists which focus on components of stable and unstable star systems which were developed earlier in the lesson.
    - Lesson 7: This element is claimed. However, no evidence of student use of the element was found.

Engaging in Argument from Evidence

- *Evaluate the claims, evidence, and/or reasoning behind currently accepted explanations or solutions to determine the merits of arguments.*
    - Lesson 6: This element is claimed. In step 7, students are asked to engage in a "building understanding" discussion for the purpose of answering the following question, "What common mechanisms might explain all three patterns we identified across the spectra of the universe?" However, students aren't asked to evaluate claims, evidence, or reasoning. They are therefore more likely to use the following 9–12 element from **Constructing Explanations and Designing Solutions**, *"Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) 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."*

Obtaining, Evaluating, and Communicating Information

- *Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.*
    - Lesson 2: This element is claimed. In step 4, students are asked to use information gathered from the Periodic Table along with patterns in star spectra data for the purpose of identifying the composition and temperature of stable stars. As students do so, they are engaging with part of the claimed SEP element. However, they are not comparing or evaluating those sources of information.
    - Lesson 3: This element is claimed. In step 4, students are provided with the "Obtaining Information Tool" that has been partially pre-filled with a variety of vetted sources of

information. Students are expected to use these sources to begin their "research cycle." As they do so, students are beginning to engage with part of the claimed SEP element for their identified research question. However, they are not comparing or evaluating those sources of information.
  - Lesson 4: This element is claimed. In step 5, students are asked to begin their second research cycle for their chosen research question. Students are instructed to use the *Obtaining Information Tool* and the *Evaluating Sources of Information Tool* while conducting this research. As they do so, students are engaging with the claimed SEP element.
- *Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.*
  - Lesson 4: This element is claimed. In step 5, students are asked to begin their second research cycle for their chosen research question. Students are instructed to use the *Obtaining Information Tool* and the *Evaluating Sources of Information Tool* while conducting this research. Although students gather information, it is unclear if they are actually assessing the evidence itself or evaluating the usefulness of each source.
  - Lesson 6: This element is claimed. In step 4, students are asked to engage in their third research cycle. Students are instructed to use the *Planning for Obtaining Information Tool*, *Evaluating Sources of Information Tool*, *Obtaining Information Tool*, and *Planning for Communication Information Tool*. While students are gathering information and using the *Evaluating Sources of Information Tool,* it is unclear if they are actually assessing the evidence itself or evaluating the usefulness of each source. Consequently, it is more likely that students are using the following 6–8 element from **Obtaining, Evaluating, and Communicating Information**, "*Gather, read, synthesize information from multiple appropriate sources and assess the credibility, accuracy, and possible bias of each publication ~~and methods used, and describe how they are supported or not supported by evidence.~~*"
- *Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).*
  - Lesson 4: This element is claimed. In step 6, students are asked to create posters to share their research findings using a gallery tour protocol. Students are told to use "a combination of words, symbols, and drawings."
  - Lesson 6: This element is claimed. In step 3, students are told that they will communicate their third round of research with their peers and that they will need to use the *Planning for Communication Tool* as a resource as they plan. In step 6, students share their research, using modalities that they choose, as part of a "timed gallery tour." Although students communicate information, it is unclear if all students will use a variety of modalities in order to do so.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit. The materials provide opportunities for students to develop and use grade-level appropriate DCI elements. However, there is some mismatch between what is claimed and what is actually used by students.

ESS1.A. The Universe and Its Stars

- *The star called the sun is changing and will burn out over a lifespan of approximately 10 billion years.*
    - Lesson 1: This element is claimed. In Section 8, students are asked to develop individual initial models of a "typical" star and a "guest star." In step 9, students work collaboratively to develop a class consensus model of "changing (guest)" and "unchanging (typical)" stars. As they do so, they are beginning to engage with the idea that stars can change and burn out. However, they are not specifically developing this understanding in reference to the sun, and they are not developing an understanding of the sun's lifespan. Consequently, students are using the following portion of the claimed element, "*~~The~~ star ~~called the sun~~ is changing ~~and will burn out over a lifespan of approximately 10 billion years~~.*"
    - Lesson 3: This element is claimed. Students engage in a research cycle to answer one of the following research questions, "Where does the energy come from to power stable stars like our Sun?", and "How does the matter in stable stars change as energy transfers?" In step 6, students engage in the "Scientists Circle" protocol in which they engage in a discussion to "integrate and compare the information they found across the multiple sources in order to answer the research questions." As they do so, it is likely that students will begin to develop an understanding that the sun, while a stable star, is changing.
    - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to surface the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and they present their findings in a poster session gallery walk in step 6. As a result of their research and the gallery walk, it is likely that students will engage with ideas that the sun is changing. However, there is no evidence that students will be developing or using ideas about the sun's lifespan.
    - Lesson 5: This element is claimed. In step 2, students develop a "Gotta Have It" checklist that "contains the components of star systems that they need to explain what is happening when a star is stable and when a guest star appears and disappears, the interactions between or within the components as well as the cause and effect relationships so they can make a model to explain why some stars seem stable while others appear to change briefly, dramatically and fade away." As students engage in a

class consensus discussion about the "Gotta-Have-It-Checklist" it is likely that students will engage with ideas that the sun is changing. However, there is no evidence that students will be developing or using ideas of the sun's lifespan. However, it is equally as likely that students will be engaging with the following element of **ESSi.A.1**, "~~*Other than the hydrogen and helium formed at the time of the Big Bang,*~~ *nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode."*

  - Lesson 7: This element is claimed. However, no evidence was found of student use of this element.
  - Part of this element is not covered anywhere in the unit.

- *The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements, and their distances from Earth.*
  - Lesson 1: This element is claimed. In step 2, students read historical observations that describe a guest star event. In step 7, students engage in a "mini lecture" in which details are shared about the 1987 guest star event. As they do so, students are engaging with ideas about the brightness of stars being used for identification and to describe their movement. However, students are not engaging with ideas about a stars' light spectrum or how it, along with brightness, is used to identify compositional elements of stars or their distances from Earth.
  - Lesson 2: This element is claimed. In step 4, students are asked to use the Periodic Table and star spectral data to come to conclusions about the composition of stable stars. As they do so, students are engaging with the following portion of the claimed DCI, "*The study of stars' light spectra and brightness is used to identify compositional elements of stars,* ~~*their movements, and their distances from Earth*~~.
  - Lesson 6: This element is claimed. In step 2, students analyze spectral data of stars, galaxies, and empty space and generate additional research questions. In step 4, students complete a third research cycle and in step 8, students engage in a "building understanding" discussion about the Big Bang. As they do so, students are engaging with the following portion of the claimed DCI, "*The study of stars' light spectra and brightness is used to identify compositional elements of stars, their movements,* ~~*and their distances from Earth*~~.
  - Part of this element is not covered anywhere in the unit.

- *The Big Bang theory is supported by observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fill the universe.*
  - Lesson 6: This element is claimed. In step 2, students analyze spectral data of stars, galaxies, and empty space and generate additional research questions. In step 4, students complete a third research cycle and in step 8, students engage in a "building understanding" discussion about the Big Bang. As they do so, it is likely that students are engaging with the following portion of the claimed DCI, "*The Big Bang theory is supported by* ~~*observations of distant galaxies receding from our own*~~*, of the measured*

composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fill the universe.
    - Part of this element is not covered anywhere in the unit.

- *Other than the hydrogen and helium formed at the time of the Big Bang, nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.*
    - Lesson 3: This element is claimed. Students engage in a research cycle to answer one of the following research questions, "Where does the energy come from to power stable stars like our Sun?", and "How does the matter in stable stars change as energy transfers?" In step 6, students engage in the "Scientists Circle" protocol where they engage in a discussion to "integrate and compare the information they found across the multiple sources in order to answer the research questions." As they do so, students are engaging with the following portion of the claimed DCI, ~~*Other than the hydrogen and helium formed at the time of the Big Bang,*~~ *nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.*
    - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to surface the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and then present their findings in a poster session gallery walk in step 6. As a result of their research and the gallery walk, it is likely that students will engage with the following portion of the claimed DCI, ~~*Other than the hydrogen and helium formed at the time of the Big Bang,*~~ *nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.*
    - Lesson 5: This element is claimed. In step 2, students develop a "Gotta Have It" checklist that "contains the components of star systems that they need to explain what is happening when a star is stable and when a guest star appears and disappears, the interactions between or within the components as well as the cause and effect relationships so they can make a model to explain why some stars seem stable while others appear to change briefly, dramatically and fade away." In step 3, students develop a series of models to "tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." As they do so, students are engaging with the following portion of the claimed DCI, ~~*Other than the hydrogen and helium formed at the time of the Big Bang,*~~ *nuclear fusion within stars produces all atomic nuclei lighter than and including iron, and the process releases*

electromagnetic energy. Heavier elements are produced when certain massive stars achieve a supernova stage and explode.
    - Lesson 6: This element is claimed. In step 2, students analyze spectral data of stars, galaxies, and empty space and generate additional research questions. In step 4, students complete a third research cycle and in step 8, students engage in a "building understanding" discussion about the Big Bang. As they do so, it is likely that students are engaging with the claimed DCI.

PS1.C. Nuclear Processes

- *Nuclear processes, including fusion, fission, and radioactive decays of unstable nuclei, involve release or absorption of energy. The total number of neutrons plus protons does not change in any nuclear process.*
    - Lesson 3: This element is claimed. In step 6, students engage in the "Scientists Circle" protocol in which they engage in a discussion to "integrate and compare the information they found across the multiple sources in order to answer the research questions." As they do so, it is likely that students will engage with the following portion of the claimed DCI, "*Nuclear processes, including fusion, ~~fission, and radioactive decays of unstable nuclei,~~ involve release or absorption of energy. ~~The total number of neutrons plus protons does not change in any nuclear process."~~*
    - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and then present their findings in a poster session gallery walk in step 6. In step 10, they engage in the Scientists Circle protocol in which they participate in a consensus discussion about what they have figured out. As they do so, it is likely that students will engage with the following portion of the claimed DCI, "*Nuclear processes, including fusion, ~~fission, and radioactive decays of unstable nuclei,~~ involve release or absorption of energy. ~~The total number of neutrons plus protons does not change in any nuclear process."~~*
    - Part of this element is not covered anywhere in the unit.

PS3.D: Energy in Chemical Processes and Everyday Life

- *Nuclear Fusion processes in the center of the sun release the energy that ultimately reaches Earth as radiation.*
    - Lesson 3: This element is claimed. Students engage in a research cycle to answer one of the following research questions, "Where does the energy come from to power stable stars like our Sun?", and "How does the matter in stable stars change as energy transfers?" In step 6, students engage in the "Scientists Circle" protocol in which they engage in a discussion to "integrate and compare the information they found across the multiple sources in order to answer the research questions." As they do so, students are

using the following portion of the claimed DCI, *"Nuclear Fusion process in the center of the sun release the energy ~~that ultimately reaches Earth as radiation.~~"*

- Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and then present their findings in a poster session gallery walk in step 6. As a result of their research and the gallery walk, it is likely that students are engaging with the following portion of the claimed DCI, *"Nuclear Fusion process in the center of the sun release the energy ~~that ultimately reaches Earth as radiation.~~"*
- Lesson 7: This element is claimed. However, no evidence was found of student use of this element.
- Part of this element is not covered anywhere in the unit.

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

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit. The materials provide opportunities for students to develop and use grade-level appropriate CCC elements. However, there is a significant mismatch between what is claimed and what is actually used by students.

Patterns

- *Empirical evidence is needed to identify patterns.*
  - Lesson 6: This element is claimed. In step 2, students analyze spectral data of stars, galaxies, and empty space to identify patterns for the purpose of generating additional research questions. Teacher guidance is provided in Lesson 1, page 29, to explain to students what is meant by "empirical data." Additionally, the following guidance is provided in the "Supporting Students in Developing and Using Patterns" callout on that same page, "In high school, students should engage with the idea that empirical evidence is needed to identify patterns. Take a moment to remind students that light is the primary source of empirical data we have about objects in space because they are too far away to collect matter from. Spectra represent a way to analyze this light and extract as much information from it as we can. This makes spectroscopy fundamental for identifying patterns to help us make sense of the universe." As a result, students are building toward the claimed CCC.

Scale, Proportion, and Quantity

- *The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.*
  - Lesson 2: This element is claimed. In steps 4 and 5, students analyze spectra of stable and guest star remnants to identify their composition and temperature. Teacher

guidance on page 46 states that students should identify that "guest stars are over ten times hotter than stars." If students make this connection, they might begin to build toward the claimed CCC. However, there is no evidence to indicate all students will be supported to do so.

- Lesson 3: This element is claimed. In step 6, students engage in the "Scientists Circle" protocol in which they engage in a discussion to "integrate and compare the information they found across the multiple sources in order to answer the research questions." Guidance is provided to "ask students to discuss the question on the slide: How does something as small as a fusion reaction between two Hydrogen atoms produce sufficient energy to power a star? Encourage students to continue the Scientists Circle format for this discussion, which focuses on student to student talk. Look for students to bring up ideas about scale, such as how big stars are, and thus how much fuel there is, or how a single reaction multiplied countless times can create a significant effect. Highlight these ideas and suggest that we expand upon the scale ideas from the anchor." As they do so, it is likely that students will engage with the claimed CCC.
- Lesson 5: This element is claimed. In step 5, using the "Scientists Circle" protocol, students work collaboratively to update the "Scale Chart" developed in a previous lesson. As they engage in the discussions to update this chart, it is likely that they are engaging in the claimed CCC.
- Lesson 7: This element is claimed. However, no evidence was found of student use of this element.

Energy and Matter: Flows, Cycles, and Conservation

- *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
    - Lesson 3: This element is claimed. In step 7, students are asked to generate a model that answers the question, "What is happening with matter and energy within stars?" Students then work collaboratively to create a consensus model of the sun to answer this question. As they do so, students are engaging with the claimed CCC.
    - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and then present their findings in a poster session gallery walk in step 6. In step 10, they engage in the Scientists Circle protocol in which participate in a consensus discussion about what they have figured out. As they engage in these steps, students might be engaging with the claimed CCC. However, there is no evidence that all students are expected to do so.
    - Lesson 7: This element is claimed. However, no evidence was found of student use of this element in the lesson.

- *In nuclear processes, atoms are not conserved, but the total number of protons plus neutrons is conserved.*
    - Lesson 3: This element is claimed. In step 7, students are asked to generate a model that answers the question, "What is happening with matter and energy within stars?" Students then work collaboratively to create a consensus model of the sun to answer this question. As students complete this activity, some students may engage with this CCC element. However, there is no evidence that they are expected to do so.

Stability and Change

- *Much of science deals with constructing explanations of how things change and how they remain stable.*
    - Lesson 1: This element is claimed. In step 9 students engage in a consensus modeling activity in which they model a "typical" star and a "guest star." Teacher guidance is provided that states, "Highlight student ideas about stability and change on the consensus model. Say, When figuring out ideas related to Earth Science and forces in Earth's Interior Unit we used a scale chart to organize our ideas about scale and stability and change. Let's see if these ideas can help us make sense of guest stars too. Present slide T. Read the top of the slide, which states 'All Systems Change. Stability is dependent on scale.' Remind students that this was at the middle of our scale chart in Earth's Interior Unit. Ask students what they think it means for stability to depend on scale in this case. Look for ideas about how even though the stars seem stable over one person's lifetime, if we look at the historical record, they change. Pose the question on the slide: How do the objects we have been investigating in the sky change over different scales? Look for students to say time. Then suggest drawing a time scale chart to keep track of the ideas about stability and change over time.?" Students might therefore begin to build toward an understanding of this element, but this idea about the nature of science is not discussed.
    - Lesson 2: This element is claimed. However, no evidence was found of student use of this element.
    - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and they present their findings in a poster session gallery walk in step 6. In step 10, they engage in the Scientists Circle protocol in which they participate in a consensus discussion about what they have figured out. As a result of the previous steps and as students respond to the suggested prompts such as, "What processes cause stars to remain stable? What causes a star to become unstable or change?", and "Does the same thing happen to every star?" It is likely that they are using the claimed element.

- Lesson 5: This element is claimed. In step 2, students develop a "Gotta Have It" checklist that "contains the components of star systems that they need to explain what is happening when a star is stable and when a guest star appears and disappears, the interactions between or within the components as well as the cause and effect relationships so they can make a model to explain why some stars seem stable while others appear to change briefly, dramatically and fade away." In step 3, students develop a series of models to "tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." As they do so, students might build toward the claimed CCC. However, it is more likely that they are using the following 9–12 CCC element, "*Feedback (negative or positive) can stabilize or destabilize a system.*"
- Lesson 7: This element is claimed. In step 1, students are asked, "How did thinking explicitly about stability and change in the universe help us make sense of our research and phenomena throughout this class?" As students respond, they might build toward the claimed CCC. However, depending on their responses, they could instead use a variety of elements and various grade levels.

- *Feedback (negative or positive) can stabilize or destabilize a system.*
  - Lesson 4: This element is claimed. In step 2, students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system. In step 3, students generate a list of research questions that could support them in figuring out "what causes stars to remain stable or become unstable and change." In step 5, students begin a second research cycle for their chosen research question and they present their findings in a poster session gallery walk in step 6. In step 10, they engage in the Scientists Circle protocol in which participate in a consensus discussion about what they have figured out. As students participate in the Scientists Circle discussion, it is likely that they are engaging with the CCC.
  - Lesson 5: This element is claimed. In step 2, students develop a "Gotta Have It" checklist that "contains the components of star systems that they need to explain what is happening when a star is stable and when a guest star appears and disappears, the interactions between or within the components as well as the cause and effect relationships so they can make a model to explain why some stars seem stable while others appear to change briefly, dramatically and fade away." In step 3, students develop a series of models to "tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." As they do so, it is likely that they are engaging with the CCC.

Suggestions for Improvement

Science and Engineering Practices

- Consider indicating to educators which elements are fully developed in the unit, which are partially developed, and which are applied from prior learning.
- Consider highlighting the strikethroughs and non-strikethrough parts of the elements in a clear place in the lessons so that teachers are aware of which portions of the elements students are intended to use or develop.

Disciplinary Core Ideas

- Consider indicating which elements are fully developed in the unit, which are partially developed, and which are applied from prior learning.
- Consider highlighting the strikethroughs and non-strikethrough parts of the elements in a clear place in the lessons so that teachers are aware of which portions of the elements students are intended to use or develop.

Crosscutting Concepts

- Consider making CCC use and development more explicit to teachers and students.
- Consider ensuring that CCC use is essential for student sense-making.

I.C. INTEGRATING THE THREE DIMENSIONS

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

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

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena or designing solutions to problems. Students have several opportunities to use multiple dimensions together in service of sense-making.

Students engage in several three-dimensional performances during the unit. Some examples include:

- Lesson 1: In step 9 students engage in a consensus modeling activity in which they model a “typical” star and a “guest star.”
  - SEP: Students begin to develop the following element from **Developing and Using Models**: *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.*

  - CCC: Students begin to develop the following element from **Stability and Change**: *Much of science deals with constructing explanations of how things change and how they remain stable.*
  - DCI: Students use a portion of the following element from **ESS1.A**: **The Universe and Its Stars**: *~~The~~ star ~~called the sun~~ is changing ~~and will burn out over a lifespan of approximately 10 billion years~~.*
- Lesson 2: In steps 4 and 5, students analyze spectra of stable and guest star remnants to identify their composition and temperature.
  - SEP: Students use the following element from **Asking Questions and Defining Problems**: *Ask questions that arise from careful observation of phenomena, or unexpected results to clarify and/or seek additional information.*
  - CCC: Students begin to develop the following element from **Scale, Proportion, and Quantity**: *The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.*
  - DCI: Students use a portion of the following element from **ESS1.A**: **The Universe and Its Stars**: *The study of stars' light spectra and brightness is used to identify compositional elements of stars, ~~their movements, and their distances from Earth~~.*
- Lesson 3: In step 7, students are asked to generate a model that answers the question, "What is happening with matter and energy within stars?" Students then work collaboratively to create a consensus model of the sun to answer this question.
  - SEP: Students use the following unclaimed element from **Developing and Using Models**: *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.*
  - CCC: Students use the following element from **Energy and Matter**: *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
  - DCI: Students use a portion of the following element from **PS3.D: Energy in Chemical Processes and Everyday Life**: *Nuclear Fusion process in the center of the sun release energy ~~that ultimately reaches Earth as radiation.~~*
- Lesson 4: In step 6, students are asked to generate posters to present their scientific research during a gallery walk.
  - SEP: Students use the following element from **Obtaining, Evaluating, and Communicating Information**: *Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).*
  - CCC: Students begin to develop the following element from **Stability and Change**: *Much of science deals with constructing explanations of how things change and how they remain stable.*
  - DCI: Students use a portion of the following element from **ESS1.A: The Universe and Its Stars**: *The star called the sun is changing and will burn out ~~over a lifespan of approximately 10 billion years.~~*

- Lesson 5: In step 3, students develop a series of models to "tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically."
  - SEP: Students use the following element from **Developing and Using Models**: *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.*
  - CCC: Students use the following element from **Stability and Change**: *Feedback (negative or positive) can stabilize or destabilize a system.*
  - DCI: Students use a portion of the following element from **ESS1.A**: **The Universe and Its Stars**: *The star called the sun is changing and will burn out ~~over a lifespan of approximately 10 billion years.~~*
- Lesson 6: In step 2, students analyze spectra data of stars, galaxies, and empty space to identify patterns for the purpose of generating additional research questions.
  - SEP: Students use an unclaimed element from **Asking Questions and Defining Solutions**: *Ask questions that arise from careful observation of phenomena, or unexpected results, to clarify and/or seek additional information.*
  - CCC: Students use the following element from **Patterns**: *Empirical evidence is needed to identify patterns.*
  - DCI: Students use a portion of the following element from **ESS1.A: The Universe and Its Stars**: *The Big Bang theory is supported by ~~observations of distant galaxies receding from our own~~, of the measured composition of stars and non-stellar gases, and of the maps of spectra of the primordial radiation (cosmic microwave background) that still fill the universe.*

Suggestions for Improvement

Supporting students to more often use grade-appropriate CCC elements in service of sense-making would strengthen the evidence for this criterion.

I.D. UNIT COHERENCE

Lessons fit together to target a set of performance expectations.

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

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

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

The reviewers found extensive evidence that lessons fit together coherently to target a set of Performance Expectations (PEs). The materials are arranged in such a way as to allow students to see the connections in learning from one lesson to another and students are supported in building proficiency in most of the targeted learning goals.

Students are given multiple opportunities to ask questions, track their learning progress related to those questions, and collaborate to develop new questions.

- Lesson 1: In step 2, students work in groups to read historical observations of guest star events. Students are asked to record questions in their notebooks and be prepared to share them with the class.
- Lesson 1: In step 10, students work collaboratively to create the DQB. Students return to the DQB to add questions and identify which questions have been answered in Lessons 2, 3, 5, and 7.
- Lesson 1: In step 11, students are given opportunities to brainstorm investigations and what data are needed to answer the questions generated in the DQB. Guidance is provided that states, "Say, which of our questions and investigation ideas are related to more closely observing the location in the sky specified by astronomers who witnessed these events? Follow up by saying let's plan to start our investigations next class with looking at some of the data collected by telescopes that have taken photographs of those places."
- Lesson 3: In step 9, students return to the DQB to add new questions. Guidance is provided to highlight student questions "about what happens when stars run out of hydrogen, explosions or supernovae or how stars die." The teacher then tells students that they will investigate the answers to those questions ("what happens when that energy runs out") the next time they meet.
- Lesson 4: In step 3, students are instructed to brainstorm research questions. Students are then told to choose a research question they wish to research with their partner.

- Lesson 5: In step 6, students return to the DQB and identify the questions they think the class has answered.

Coherent links are made between lessons for students throughout the unit. Related evidence includes:

- Students use the Progress Tracker tool to track their learning throughout the unit. For example:
    - Lesson 2: In step 2, students begin using the Progress Tracker to record what they have figured out related to the following provided question, “How does the matter in the remnants of a guest star compare to stable stars?” Students continue to add to their Progress Tracker in step 5.
    - Lesson 3: In step 8, students use their Progress Tracker in response to the prompt, “Ask students if they have made progress on making sense of guest stars and stable stars.”
    - Lesson 4: In step 11, students are presented with the following question, “What causes stars to remain stable or become unstable and change?” Students then record their responses using their Progress Trackers.
    - Lesson 5: In step 2, students are asked to develop a “Gotta-Have-It" checklist to identify “What causes stars to remain stable or become unstable and change?” Students use information they have previously recorded on their Progress Tracker as they work to create this list.
    - Lesson 6: In step 6, students are presented with the following prompt. “What is the composition of the whole universe and how it has changed over time?” They are asked to record what they have figured out in their Progress Tracker.
- Consensus models are constructed and updated during the unit, connecting students’ learning together from one lesson to the next. For example:
    - Lesson 1: In step 9, students work collaboratively to generate an individual consensus model of “typical stars” and “guest stars.”
    - Lesson 3: In step 7, students work collaboratively to develop a consensus model of a “stable star.”
    - Lesson 4: In step 10, students return to the “stable star” model after having a consensus discussion to “reflect on how their understanding has changed based on their research.”
    - Lesson 5: In step 4, students work collaboratively to develop a consensus model that "explains all the different types of star systems we have been considering.” Students are provided with the following prompts, “Does our model describe what keeps most stars stable for a very long time? Does our model explain what causes guest stars to appear in the sky suddenly, and then disappear? Does our model predict what will eventually happen to our Sun?” and are encouraged to add to their consensus model until they can answer all of the presented questions.

Students are supported in building towards proficiency in most of the learning from the targeted PEs. See related evidence under Criterion I.B. Claimed PE targets are:

- **HS-ESS1.1:** *Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun’s core to release energy that eventually reaches Earth in the form of radiation.*

- **HS-ESS1-2:** *Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies and composition of matter in the universe.*
- **HS-ESS1-3:** *Communicate scientific ideas about the way stars, over their life cycle produce elements.*
- **HS-PS1-8:** *Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.*

Suggestions for Improvement

- Consider providing students with opportunities to progressively build toward all parts of each element that makes up the targeted PEs such that students would be able to perform the PEs by the end of the unit.
- Consider providing teachers with information about how to assist students in mastering full PEs. Throughout the unit students use elements of all three dimensions frequently. However, it isn't clear that students are supported to fully develop the elements that make up the full PEs identified for the unit.

I.E. MULTIPLE SCIENCE DOMAINS

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

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

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

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

The reviewers found adequate evidence that links are made across the science domains when appropriate. Connections are somewhat made between the Earth and physical science domains as students make sense of the unit phenomenon. However, students are not supported in explicitly using elements from CCCs to make connections across science domains.

Students connect both Earth and physical science concepts to make sense of the guest star phenomenon. However, the unit's topic can mostly be explained using the Earth Science domain. Related evidence includes:

- The anchoring phenomena is mostly explained using the DCI **ESS1.A: The Universe and its Stars.** Lessons 1 and 2 focus on students investigating photos and spectra of the remnants of guest stars before they begin to research questions in small groups. These research questions support them in engaging with content from the two physical science DCIs **PS1.C: Nuclear Processes** and **PS3.D: Energy in Chemical Processes and Everyday Life** in Lessons 3 and 4. The research questions for these two lessons feature concepts of nuclear fusion processes in the center of the sun, tying back to the concepts of Lessons 1–2 of stable and unstable stars. Lessons 5–7 focus back on DCI **ESS1.A: The Universe and its Stars,** when students take a closer look at feedback loops and the role they play in stable and unstable stars as well as the Big Bang Theory.

Grade-appropriate elements of CCCs are used to make connections across science domains. However, these few instances below are not explicitly made for students. For example:

- Lesson 3, step 7: Students model our sun, a stable star. The teacher is told, “Students’ models show high heat in the core of the sun causes particle nuclei to collide and fuse together, particle nuclei fusing and releasing energy, two hydrogen atoms fusing together to become one helium atom and the total number of protons plus neutrons are conserved but atoms are not.” Students are prompted to, “Use the ideas we obtained from our sources to develop a model that explains: What is happening with matter and energy within stars? How might this help us make progress on our investigation of guest stars? Students conclude that a large number of tiny scale fusion reactions occurring inside a star are responsible for the enormous amounts of energy produced at the scale of the sun.”
- Lesson 4, step 2: Guidance is provided to the teacher to, “Forecast a feedback loop. Use the first prompt on the slide to ask students what will happen to the forces causing fusion if the core of the star expands and pushes outward. As the core of the star expands, the concentration of hydrogen particles decreases so fusion slows down and the core will contract a little bit. That way if the star gets too hot, it has a way of cooling itself down. Ask, will this help the star stay stable, or make it unstable? Why do you think that?”
- Lesson 5, step 3: Students are asked to individually develop models that “identify that scale is significant within stable stars because atomic scale fusion processes within the core drive stellar-scale forces to keep the star in equilibrium.”

Suggestions for Improvement

- Consider supporting students to explicitly see how grade-appropriate elements of the CCCs are useful across science domains.

I.F. MATH AND ELA

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

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

The reviewers found adequate evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS). Specific CCSS English language arts (ELA) standards are claimed and used by the students, and they are provided with multiple opportunities to speak and listen to their peers.

Materials explicitly state ELA standards that are used in the unit using "Supporting Students in Making Connections to ELA" call-out boxes at the end of specified lessons. However, the materials do not support students in seeing the connections between literacy and science.

Related evidence includes:

- **CCSS.ELA-Literacy.RI.11-12.7:** *Integrate and evaluate multiple sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words to address a question or solve a problem.*
  - Lesson 3: "Students gather and evaluate sources of information from online media. The students begin considering what makes a source credible, record information from multiple sites and record relevant information to answer the question they chose including ideas about fusion in the sun or stars through the lenses of energy and matter."
  - Lesson 4: "In the second research cycle students use the checklist for multiple resources and only seek to gather information once they have decided a source is credible and the information must be relevant to the question of what causes stars including the sun to remain stable or become unstable and change."
  - Lesson 6: "Students gather and evaluate sources of information from online media. The sources of information in different formats have to be integrated in order to address the research questions."
- **CCSS.ELA-Literacy.RST.9-10.2:** *Determine the central ideas or conclusions of a text, trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.*
  - Lesson 4: "Students gather, read, evaluate and integrate information from multiple authoritative internet sources assessing the evidence and usefulness of each source in answering the questions about how stars, including our sun, remain stable and can become unstable over their life cycles and communicate the information with a poster."

  - Lesson 6: "Students read, evaluate and communicate information about the Big Bang theory to explain that it is supported by empirical evidence of spectral patterns including observations of distant galaxies receding from our own, of the measured composition of stars and non-stellar gases and of the maps of spectra of the primordial radiation."
- **CCSS.ELA-Literacy.SL.9-10.4:** *Present information, findings, and supporting evidence clearly, concisely, and logically so that listeners can follow the line of reasoning and the organization, development and substance and style are appropriate to purpose, audience and task.*
  - Lesson 4: "Students present their findings clearly on a poster during the gallery tour."
  - Lesson 6: "Students present their findings clearly using a medium of their choice."

There are no CCSS in mathematics identified for the unit. However, there are opportunities when the mathematical practices could be used in concert with the CCC **Scale, Proportion, and Quantity** to help students make sense of phenomena. For example:

- **HSN-Q.A.2** *Define appropriate quantities for the purpose of descriptive modeling.*
  - Lesson 5, step 5: Using the "Scientists Circle" protocol, students work collaboratively to update the "Scale Chart" developed in a previous lesson. This is a missed opportunity to make a connection to the CCSS.
- **HSN-Q.A.3** *Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.*
  - Lesson 2, steps 4 and 5: Students analyze spectra of stable and guest star remnants to identify their composition and temperature. Teacher guidance on page 46 states that students should identify that "guest stars are over ten times hotter than stars." This is a missed opportunity to make a connection to the CCSS.

Students are provided with several opportunities to engage in reading, writing, speaking, and listening throughout the unit. Related evidence includes:

- Lesson 1: In step 2, students read about historical observations of another guest star.
- Lesson 1: In step 7, students listen to a "mini-lecture" about the 1987 guest star event. Students are instructed to take notes on what they hear.
- Lesson 4: In step 9, students create posters to communicate their research findings. Students are instructed to use a variety of modes of communication (texts and graphics).
- Lesson 6: In step 6, students develop a way to communicate their research findings with their peers. They are encouraged to use a "variety of modalities" to adequately share their discoveries during a timed gallery walk.

Suggestions for Improvement

- Consider providing explicit connections to ELA standards, including those from prior grade levels, when students read and write in the unit.
- Consider providing explicit connections to mathematics standards wherever students analyze data and use mathematical concepts in the unit.

Stars and the Big Bang

EQuIP RUBRIC FOR SCIENCE EVALUATION

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

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

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

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

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

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

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

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world. Students have opportunities to experience phenomena and problems as directly as possible and the unit includes suggestions for how teachers can help connect instruction to students' lives.

Students experience the anchor phenomena/problem as directly as possible and are supported to become engaged in wanting to learn. Related evidence includes:

- Lesson 1: Students are introduced to the guest star phenomena through multiple historical readings and by use of a constellation map to locate where the event took place.
- Lesson 2: Students analyze images of guest star remnants and the sun before analyzing spectra of stable stars.
- Lessons 3, 4, 5 and 6: The students conduct research on websites that contain several photographs and information about star life cycles and the Big Bang theory.
- Lesson 7, step 2: Students are given an opportunity to create a "Future Question Board" composed of any new questions they wish to investigate on their own. Questions students raise could be evidence that students are authentically engaged and curious.

Suggestions for how to connect to students' lives and communities are provided. Some examples include:

- Lesson 1, page 23: Guidance is provided to support teachers as they navigate students not being able to observe stars in the night sky due to light pollution, cultural traditions, or safety.
- Lesson 1, page 23: Guidance is provided to ask students about traditions or stories they've heard about the night sky from family or community.
- Lesson 1, page 24: Students are asked to identify an example of a system that they have seen or learned about that seemed to be stable then changed quickly.

- Lesson 1, page 24: Guidance for identifying related phenomena to support students in making connections to the anchoring phenomena and experiences they may have had in the past are provided. “This Related Phenomena poster is used to broaden students’ thinking to related phenomena and leverage prior science experiences they have inside and outside of school to support the learning that happens in the classroom. Connecting the stellar anchoring phenomena to students’ experience with stable and unstable systems helps the phenomenon become more personally meaningful to each student, supporting their engagement with it.”
- Lesson 1, page 28: Students are asked to share their own experiences, cultural traditions, or experiences of a trusted family member or adult regarding stories, experiences, or connections to stars or changes in stars that they’ve observed. Students then share these with the class.

Suggestions for Improvement

- Providing students with additional opportunities, throughout the unit, to connect the activities, lesson-level phenomena, or the anchoring problem to their own experiences, communities, or cultures would strengthen the rating for this criterion.

II.B. STUDENT IDEAS

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

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

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas.

Students have multiple opportunities to express, clarify, justify, and represent their ideas during the unit. Some examples include:

- Lesson 1: In step 1, students share their “notice/wonder” observations with a partner.
- Lesson 1: In step 6, students are presented with the following prompt, “How would this spectrum support the claim that hydrogen is one of elements that make up the Sun?” and are given an opportunity to “turn and talk” about the prompt.
- Lesson 1: In step 8, students share their models using the “M-E-F" lens.
- Lesson 2: In step 2, students are asked to “turn and talk” about the following prompts, “What inferences can we make about the differences between stable stars and guest stars? What do they tell us may have happened to the matter that made up the guest star?”

- Lesson 2: In step 4, students are presented with the following prompt, "How would this spectrum support the claim that hydrogen is one of elements that make up the Sun?" and given a set amount of time to discuss their ideas with a partner.
- Lesson 3: In step 1, students are given a series of prompts that they discuss with a peer. Students are then put in groups and given time to discuss research questions.
- Lesson 4: In step 4, students work with a partner to choose a question they wish to research.
- Lesson 5: In step 2, students discuss the cause-and-effect feedback loops.

Students have some structured opportunities to receive and respond to peer feedback. Some examples include:

- Lesson 4: In step 8, an alternate activity that suggests that students could provide feedback to another group's poster prior to the gallery tour is provided. However, as this is an alternate activity, it is less likely that all classrooms will use it.
- Lesson 5: In step 3, students are instructed to "take turns sharing their models with a partner and providing feedback." They are encouraged to use their "Gotta-Have-It" checklist as a tool for providing the feedback.
- Lesson 6: In step 5, students are encouraged to provide feedback on each other's communication plans if they finish early.

Students have some structured opportunities to receive and respond to teacher feedback. Some examples include:

- Lesson 3: In step 4, guidance is provided to, "Collect Planning for Obtaining Information Tool and Pre-Filled Obtaining Information Tool and provide written feedback to students on their progress so far before next class."
- Lesson 4: In step 7, guidance is provided to give feedback using sticky notes so students can make revisions as they finish posters.
- Lesson 5: In step 3, guidance is provided to provide feedback to students' "Feedback Loop Modeling" using provided example student models.
- Lesson 5: In step 7, students are assigned an "Exit Ticket" assessment. The Exit Ticket Answer Key includes targeted feedback suggestions for the teacher to give the students.
- Lesson 6: In step 4, Assessment Opportunity guidance prompts teachers to, "Move around the room to support students during this time and provide feedback on their work. Consider collecting artifacts of student work at the end of class to provide written feedback for students who complete the research cycle."

Throughout the unit, student artifacts include written or oral models of reasoning and students are supported to reflect on their changing thinking over time. For example:

- Use of the Progress Tracker throughout the unit supports students in documenting how their understanding of concepts changes over time.
    - Lesson 2: After students analyze images of guest star remnants and the sun students complete their Progress Tracker to record what they have figured out so far about how

the matter in the remnants of a guest star compare to stable stars. Then, they add their findings about guest star spectra to their Progress Tracker.
    - Lesson 3: After learning more about guest stars and stable stars students record their new findings on their Progress Trackers.
    - Lesson 4: Students learn about feedback loops and how systems are kept in equilibrium before recording their ideas in their Progress Trackers.
    - Lesson 6: After reading about the Big Bang Theory, students add their new learning to their Progress Trackers.
- Lesson 4: Students create a poster to communicate their findings about their research question.

Suggestions for Improvement

Consider providing more guidance to students as they provide peer feedback to ensure the content of the feedback will be relevant to students' thinking.

II.C. BUILDING PROGRESSIONS

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

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

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

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions. Prior student learning expected for the dimensions is identified in the materials and a learning progressions chart is included. However, the materials rarely identify the expected levels of prior proficiency students should have for each of the three dimensions.

Related evidence includes:

- The Teacher's Guide (page 13) identifies the DCI elements that students are expected to have learned in prior grade bands and states that, "This unit uses and builds upon Disciplinary Core Ideas (DCIs) and other science ideas that students should have previously developed in the OpenSciEd High School Biology and Chemistry courses and previous units in this physics course." However, individual elemental level of prior proficiency of these DCI elements is not included.
- The Teacher's Guide identifies SEPs and "(CCCs) that students should have previously developed in OpenSciEd High School Biology and Chemistry" (Teacher's Guide, page 15). The Teacher's

Guide states the specific OpenSciEd units where students should have developed the SEPs and CCCs and in which lessons in this unit students will continue to develop those SEPs and CCCs. However, individual elements of these dimensions are not listed, and levels of prior proficiency are not included.

- The Teacher's Guide states that, "Students will come into the unit with many ideas about energy derived from previous classroom experiences, intuitive understandings of the way the world works, everyday experiences with movement, and the conversations they have had with parents, friends, and family members" (Teacher's Guide, page 16). There are also several lesson-specific concepts that students may already hold that are listed.
- Each lesson includes a "Where we are going and NOT going" section that includes information that identifies prior student learning in at least two of the three dimensions in the lesson. However, the expected level of proficiency for this prior learning is not identified. For example:
    - Lesson 2, page 40: The following guidance is provided. "Students who have taken chemistry, particularly if they have experienced OpenSciEd Unit C.3: How could we find and use the resources we need to live beyond Earth? (Space Survival Unit), will be relying on their understanding of the following disciplinary core idea element in this lesson to make sense of spectra: PS4.B.4: Atoms of each element emit and absorb characteristic frequencies of light. These characteristics allow identification of the presence of an element, even in microscopic quantities. (secondary to HS-ESS1-2)."
    - Lesson 4, page 69: The following guidance is provided for the SEP element of **Obtaining, Evaluating and Communicating Information**. "This element has been developed across Lessons 2 and 3. This lesson culminates students' engagement with this element through having them do a more detailed evaluation of sources they find themselves as well as continuing to compare and integrate across multiple sources to answer their scientific questions." However, guidance about whether and how any new learning will occur is not provided.
    - Lesson 5, page 86: The following guidance is provided for the CCC **Scale, Proportion and Quantity**. "This lesson continues students' use of this concept from Lesson 3 to include both the previously established significance of atomic-scale processes driving stellar-scale stability and the significance of star mass in what happens at the end of a star's life. This element will be visited again in the Transfer Task in Lesson 7." However, guidance about whether and how any new learning will occur is not provided.

Suggestions for Improvement

- Consider explicitly stating the expected prior level of proficiency students should have for all elements in order to engage successfully with the materials.
- In the "Where We Are Going" sections, consider clearly describing for teachers whether and how student proficiency in each learning goal for all three dimensions is expected to progress from one lesson to the next.

II.D. SCIENTIFIC ACCURACY

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

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

The reviewers found extensive evidence that the materials use scientifically accurate and grade-appropriate scientific information. All science ideas and representations in the materials are accurate.

Additional background information is given to teachers about some of the topics in the unit. For example, the section titled, "What are recommended adult-level learning resources for the science concepts in this unit" contains additional websites that teachers can visit to support them in better understanding the unit concepts.

- "To learn more about historical supernovae: The Historical Supernovae (out-of-print book, easily available at used bookstores): Clark, D. H.; Stephenson, F. R. (June 29, 1981). 'The Historical Supernovae'. Supernovae: A survey of current research; Proceedings of the Advanced Study Institute. Cambridge, England: Dordrecht, D. Reidel Publishing Co., 7-Naked Eye Supernovae Throughout Human History (Astronomy Magazine article): https://astronomy.com/news/2020/11/7-naked-eye-supernovae-throughout-human-history, Blasts from the Past: Historical Supernovas (Infographic from NASA/Chandra X-ray Observatory): https://chandra.harvard.edu/resources/handouts/lithos/hist_remnants.pdf" (page 17).
- "To learn more about stellar evolution: What Happens If A Star Explodes Near The Earth? (Veratiserum video about supernovae): https://www.youtube.com/watch?v=evUfG3lrk5U, Introduction to the Hertzsprung-Russell diagram (from Australia Telescope National Facility): https://www.atnf.csiro.au/outreach/education/senior/astrophysics/stellarevolution_hrintro.html" (page 17).

Suggestions for Improvement

N/A

II.E. DIFFERENTIATED INSTRUCTION

Provides guidance for teachers to support differentiated instruction by including:

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

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

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

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

The reviewers found adequate evidence that the materials provide guidance for teachers to support differentiated instruction. Strategies are provided to explicitly support students who are struggling with learning targets, read below grade level, or are multilingual learners. However, many of these strategies are generalized instructional moves and are not specifically designed to provide explicit support related to the targeted learning goals.

Some strategies are provided to address the needs of multilingual learners, learners with disabilities, and those who read below grade level. Some examples include:

- Students are supported in developing personal glossaries throughout the unit. The Teacher's Guide explains that, "The definitions we co-construct and encounter in this unit are listed in this document and in each lesson to help prepare and to avoid introducing a word before students have earned it. They are not intended as a vocabulary list for students to study before a lesson, as that would undermine the authentic and lasting connection students can make with these words when they are allowed to experience them first as ideas they're trying to figure out." (page 18). Lesson materials explicitly call out when to support students in the development of their personal glossaries.
- Lesson 1: When students read about other guest stars, readings are written to provide differentiation to students at different reading levels.
- Lesson 1, page 25: The following support is provided. "The readings include English translations from several languages including Old Chinese, Italian, Egyptian (Coptic), and Persian (Farsi). If any students in your class can read or speak one of these languages, and feel comfortable volunteering this information, ask them to bring the language alive for the class. Make it clear that this knowledge is valuable in science class. Celebrating students' diverse linguistic practices in the classroom is a way to make pedagogy sustaining of students' home cultures."

- Lesson 1, page 30: The following support is suggested for "Supporting Multilingual Learners: science. This 'mini-lecture' is designed to support students as they transition out of high school. It provides a lot of information in multiple modalities all at once, which can be overwhelming. To help your students develop tools to be successful in lecture, consider first giving students time to read the slide before you speak. You can print out slides M-O for them to annotate and add to their notebooks so that they do not feel pressured to record the details on the screen. Pause at the end of each slide, and ask a student to summarize what they added to their notes for that slide before moving on, and give other students a chance to add to their notes as well."
- Lesson 1, page 32: The following support is suggested, "Supporting Multilingual Learners: Allowing students to use multiple languages allows them to use their full repertoires to make sense of phenomena. The main purpose of the initial modeling is to organize ideas that can then be collected into the consensus model. This means that it is not imperative that everyone can understand each individual's model without facilitation. If you are reviewing a model in which a student used another language and you need to know what they mean, use it as a learning experience and ask them to explain their sensemaking."
- Lesson 3, page 53: The following guidance is provided. "Some students, particularly students with learning differences, below grade-level reading, or students who are emergent multilingual learners, may benefit from additional support. Pre-Filled Obtaining Information Tool provides sources for each question. In general, the sources are about at the 11th grade level with each list containing a more challenging text. The reading levels of individual sources are provided on L3 Research Key. These are more challenging readings and parts of them may be difficult for students to access. However, since this is the last unit of the course and it focuses on obtaining information from internet resources, these have been chosen to help bridge students to accessing the wide variety of resources they will find while conducting their own searches in future lessons. Be ready to support students with strategies for reading challenging texts. See suggestions for supporting students is provided in the OpenSciEd Teacher Handbook: High School Science. A differentiated third set of resources are provided on Alternate Pre-Filled Obtaining Information Tool that are at a more accessible reading level. These sources do provide less detailed information, but still provide enough that students will be able to contribute to the class discussion and engage in comparing and integrating over multiple sources."
- Lesson 4, page 75: The following guidance is provided. "Adding the additional layer of using Evaluating Sources of Information Tool and Evaluating Online Sources Overview to evaluate sources may be overwhelming for some students. Consider forming a study group that you guide through examples of how to navigate sources while using these evaluation tools." This strategy is called out for multilingual learners. However, it is a generalized instructional move that could benefit many types of learners.

While there are suggestions to support students struggling to meet learning targets provided after assessment opportunities, there is little guidance provided elsewhere in the lessons. When present outside the explicit assessment opportunities, the guidance for struggling students does not explicitly address specific learning targets and are instead generalized instructional moves for the teacher. Some examples include:

- Lesson 1, page 24: The following guidance is provided. "Universal Design for Learning: this Related Phenomena poster is used to broaden students' thinking to related phenomena and leverage prior science experiences they have inside and outside of school to support the learning that happens in the classroom. Connecting the stellar anchoring phenomena to students' experience with stable and unstable systems helps the phenomenon become more personally meaningful to each student, supporting their engagement with it."
- Lesson 4, page 78: The following guidance is provided. "If students are struggling to hit all the key ideas, use guiding questions or point to individual posters for ideas that haven't been covered yet." However, this is not a strategy to support struggling students and is instead a generalized instructional move.
- Lesson 5, page 87: The following guidance regarding an alternative activity is provided. "If students are struggling with thinking about the feedback loops in the things listed on the Related Phenomenon poster consider going through the following example as a class."

Some options are provided that could help students who have already met the PEs. However, most of these options do not explicitly address specific learning targets and are instead generalized instructional moves for the teacher. Some examples include:

- Lesson 2, page 45: The following Alternate Activity/Extension Opportunity is suggested. "GuestStar Spectra v2 has the annotations related to missing hydrogen and helium removed, that are included in GuestStar Spectra. The removal of these annotations increases the opportunity for student sensemaking and prepares students more for the type of independent research and spectral analysis they will need to be doing in future lessons. If you choose to use GuestStar Spectra v2 instead of GuestStar Spectra v2, you may want to also allocate an additional 3 minutes for the work on slide Z."
- Lesson 6, page 110: The following Alternate Activity/Extension Opportunity is suggested. "Encourage students who could benefit from an extension opportunity to research and compare various visual models for the Big Bang and the history of the universe. This may include visualizations of the Cosmic Microwave Background, horn-shaped models of the Universe across time, or timelines of the history of the Universe. Ask students to respond to these prompts: What do each of these models tell us about the Big Bang? How does the evidence we uncovered relate to each of these models?"

Suggestions for Improvement

- Consider providing additional strategies that help students meet the targeted expectations for all three dimensions.
- Consider explicitly identifying the student needs that will be supported by differentiation strategies.
- Consider describing supports for students who start the unit at significantly higher or lower levels of expected proficiency in the unit pre-requisites.

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

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time. Guidance is provided for teachers to support linking student engagement across lessons. However, there is inconsistent guidance for teachers to help students understand how their learning progresses in all three dimensions as they engage in sense-making.

Throughout the unit, several tools are provided to support teachers in linking student engagement across lessons. Related evidence includes:

- The Teacher's Edition, pages 3–6, includes a Unit Storyline document, which provides a brief overview of each lesson in the unit. This Unit Storyline also includes a statement explaining how to navigate to the next lesson with key learning listed.
- Each lesson includes a section that summarizes "Where We Are Going and NOT Going." This section provides clarification on which DCI, SEP, and CCC elements are being targeted and often includes specific language about the middle school units that may provide prior support for current learning targets. This section also provides clarification about what the lesson materials are not attempting to develop.
- The "Learning Plan Snapshot" pages at the beginning of each lesson give a summary of the student actions before, during and after each lesson.
- The Teacher's Edition includes sections titled, "How is this unit structured" (page 9) and "What are the three-dimensional ideas in the context of the unit" (page 11).
- The DQB is developed in Lesson 1 and used to brainstorm questions about the phenomenon. Students revisit the DQB in Lessons 2, 3, 5, and 7 to determine what questions have been answered and to record new questions.
- Guidance is provided for how to support students in using the Progress Tracker as a tool to monitor what they have figured out over the course of the unit. However, the guidance focuses heavily on helping students see their progress in their DCI understanding rather than in all three dimensions. For example:

- Lesson 2, page 43: "Cue students to prepare a progress tracker to record what they have figured out so far related to this question for two minutes: How does the matter in the remnants of guest stars compare to stable stars?" While students check which CCC lens they are using, they are primarily reflecting on the DCI knowledge they have gained.
- Lesson 3, page 62: "Record ideas in progress trackers. Ask students if they have made progress on making sense of guest stars and stable stars. Have them record what they have figured out in their progress trackers. They can use the consensus model and important ideas charts." While students check which CCC lens they are using, they are primarily reflecting on the DCI knowledge they have gained.
- Lesson 4, page 80: "Ask students if they have made progress on answering the question. Then have them take out their progress tracker and record what they have figured out" While students check which CCC lens they are using, they are primarily reflecting on the DCI knowledge they have gained.
- Lesson 6, page 109: "If there is time, bring the class back together adding to the progress tracker to elicit new ideas from the reading." While students check which CCC lens they are using, they are primarily reflecting on the DCI knowledge they have gained.

* Some guidance is provided to help students see that their CCC learning is helpful in sense-making. For example:
    - Lesson 3, page 60: Students model our sun, a stable star. "Use the ideas we obtained from our sources to develop a model that explains: What is happening with matter and energy within stars? How might this help us make progress on our investigation of guest stars? Students conclude that a large number of tiny scale fusion reactions occurring inside a star are responsible for the enormous amounts of energy produced at the scale of the sun."
    - Lesson 4, page 72: "Forecast a feedback loop. Use the first prompt on the slide to ask students what will happen to the forces causing fusion if the core of the star expands and pushes outward. As the core of the star expands, the concentration of hydrogen particles decreases so fusion slows down and the core will contract a little bit. That way if the star gets too hot, it has a way of cooling itself down. Ask, will this help the star stay stable, or make it unstable? Why do you think that?"
    - Lesson 7, page 117: Students are asked, "How did thinking explicitly about stability and change in the universe help us make sense of our research and phenomena throughout this class? Accept all ideas. Look for students to see how stability and change is fundamental to thinking productively about natural phenomena and to talk about the use of the scale chart."

Suggestions for Improvement

Consider more often including explicit teacher guidance and strategies for supporting students to see how their learning in SEPs and CCCs connects to their sense-making and problem solving.

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

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

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

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time. Scaffolding for some SEP elements is reduced across lessons, but the scaffolding is not always reduced over time in a logical way that supports students using the elements more independently over the course of the unit.

The "What elements of the NGSS are being developed" section, page 12 of the Teacher's Guide, clearly states that three SEP elements from **Obtaining, Evaluating and Communicating Information** are to be developed in the unit. However, the initial scaffolding of the targeted SEP elements is unclear, and the scaffolds are not always reduced gradually over time. Related evidence includes:

- *Compare, integrate, and evaluate sources of information presented in different media or formats (e.g. visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.*
    - Students are using this element multiple times throughout the unit, but there is no evidence of supports being adjusted over time. For example, the element is claimed in Lessons 2, 3, and 4, but students complete the "Obtaining Information Tool" with partners and not independently in both Lessons 3 and 4.
- *Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources assessing the evidence and usefulness of each source.*
    - Students are using this element multiple times throughout the unit, but there is no evidence of supports being adjusted. For example, students use the "Planning for Obtaining Information" tool in both Lessons 4 and 6.
- *Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, and mathematically).*
    - There is some evidence of supports being adjusted for the following SEP element:
        - Lesson 4: With a partner, students use the information gathered in the second research cycle to create a poster to communicate their findings. Students are not presenting this information in multiple formats at this point in the unit.
        - Lesson 6, page 104: Students work with a partner to present information gathered in the third research cycle to communicate their findings. The following guidance is provided. "For this research cycle, your group will choose what format you want to communicate your findings. Have a few students share

their thoughts. Look for students to offer a variety of modalities such as a poster, 3D models, text, article or presentation."

Suggestions for Improvement

Consider including progressively-reduced teacher scaffolds so that students are able to use the elements more independently or deeply by the end of the unit.

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

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

III.A. MONITORING 3D STUDENT PERFORMANCES

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

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

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena or design solutions. Students produce artifacts that require them to use more than one dimension in service of problem solving or sense-making. However, there is a significant mismatch between assessment targets and assessment prompts, and not all of the summative assessment opportunities are driven by phenomena or problem-based scenarios.

Many opportunities to monitor students' progress in the three dimensions are included in the unit. However, they sometimes claim to assess elements that aren't required by the tasks. For example:

- Lesson 1, step 9: Students engage in a consensus modeling activity in which they model a "typical" star and a "guest star." As they do so, students are most likely using an element from **ESS1.A.1: The Universe and Its Stars**. They might also use an element from **Developing and Using Models**, and an element from **Stability and Change,** but the prompts don't clearly require these elements at a high-school level.
- Lesson 3, step 7: Students are asked to generate a model that answers the question, "What is happening with matter and energy within stars?" As they do so, students are most likely using an element from **PS3.D: Energy in Chemical Processes and Everyday Life,** along with an element from **Developing and Using Models**, and an element from **Energy and Matter**.
- Lesson 4, step 6: Students are asked to generate posters to present their scientific research during a gallery walk. As they do so, students are most likely using an element from **ESS1.A.1: The Universe and Its Stars**, along with an element from **Obtaining, Evaluating, and Communicating Information**. An element from **Stability and Change** is also targeted**,** but the prompts do not clearly require this element at a grade-appropriate level.
- Lesson 5, step 3: Students develop a series of models to "tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." As they do so, students are most likely using an element from **ESS1.A.1: The Universe and Its Stars**, along with an element from **Developing and Using Models**. An element from **Stability and Change** is also targeted**,** but the prompts do not clearly require this element at a grade-appropriate level.

Whole group formative assessments are sometimes included in the assessment guidance. However, the teacher is not always prompted to collect evidence of individual students' performance in these cases. For example:

- Lesson 2, step 6: Students share questions that they have generated about stars in general and guest stars in particular. Guidance is provided as to what to "look/listen" for and suggested student questions are presented. However, this is a whole group formative assessment opportunity and there is no guidance provided to support teachers in discerning individual student understanding.
- Lesson 4, step 3: Students brainstorm research questions that would help them figure out what makes some stars stable and some unstable. Guidance is provided as to what to "look/listen" for and suggested student questions are presented. However, this is a whole group formative assessment opportunity and there is no guidance provided to support teachers in discerning individual student understanding.

Formal summative assessment tasks are identified in Lessons 5 and 7. However, these tasks are not always focused on phenomena- or problem-driven scenarios. The Lesson-by-Lesson Opportunities table lists each item and each element it aligns with for both summative tasks. Related evidence includes:

- Lesson 5: At the conclusion of the lesson students are given a multiple-choice Exit Ticket that features questions that ask students to show that they "know" the language that describes DCIs, SEPs and CCCs, but does not ask students to demonstrate understanding via application or integration. The Exit Ticket directions state, "This electronic exit ticket addresses 3-D elements associated with the lesson-level performance expectations from Lesson 5 which is the putting pieces together routine for the first lesson set in the unit. This assessment is designed to be easy to gather information about where your students are struggling to put the pieces together" (page 149).
- Lesson 7: This summative assessment requires students to complete a transfer task about Jupiter and the sun. Students are engaged in sense-making and the task requires students to reason and connect their existing understanding and abilities to the new information provided.

Suggestions for Improvement

Consider revising the summative task for Lesson 5 so that it provides an opportunity for students to show what they know and can do in the context of sense-making or problem solving.

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

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction. Formative assessments opportunities are identified throughout the unit and some guidance for how to modify instruction is provided. However, there are few suggestions designed for addressing a range of students' individual needs.

Related evidence includes:

- Lesson 1, step 8: Students develop models to "explain why the stars we see in the night sky appear not to change, while historical accounts of guest stars describe them changing dramatically." The following guidance for "what to do" is provided. "If students are struggling invite them to begin recording questions they have that are making it hard to model. They can bring these to the scientists' circle even if they don't have a model yet", and "If students are struggling with how to make a distinction between the two models (or if students feel that they already know what is happening), use the M-E-F triangle to prompt them to focus on specific differences in the makeup of the stars the way energy is transferring, or even the forces think may be at work."
- Lesson 3, step 7: Students develop a model that explains "What is happening with matter and energy within stars?" Suggestions for feedback are provided. However, guidance for how to modify instruction is not provided.
- Lesson 4, step 11: Guidance is provided to collect student posters for review. Suggestions for "What to Do" are provided. However, all of this guidance is focused on SEP use.
- Lesson 5, step 3: Students are asked to, "Develop a series of models to tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically." "What to Do" guidance is provided to the teacher.

In most of the Assessment Opportunity sections, there are notes to the teacher about how to use the results of the formative assessment to modify instruction. However, few formative assessment supports are provided to attend to the needs of individual students who may need alternative means of expression at the time of the lesson. Some evidence includes:

- Lesson 3, step 4: Students are asked to complete the Planning for Obtaining Information Tool and the Pre-filled Obtaining Information Tool to begin research cycle 1. Guidance is provided that states, "If students need more scaffolding as they research, be ready to work through examples as a class in Lesson 4 before jumping into independent research using the Evaluating

Information Tool." However, students are not provided with support in Lesson 3. In addition, this guidance does not include suggestions for individualized student support.

- Lesson 4, step 4: As students prepare for another research cycle an "Alternative Activity" guidance is provided. "If some of your students need extra support accessing textual information, prepare more accessible resources ahead of the next class. Search for relevant sources to the research questions the class developed and look for sources such as videos, resources written at a more accessible reading level or resources that incorporate more visual representations that can supplement the textual information."
- Lesson 4, step 11: Guidance is provided to collect student posters for review. The following guidance is provided. "Take note of how students are communicating information within their posters. Assessment of this should be formative in this lesson, as supports have not been provided for communicating information yet. Use this opportunity to assess what students will need extra support on when this is the focus for Lesson 6. Refer to the Planning for Communication Information Tool and Presentation Rubric in the Lesson 6 materials to fully understand what the future expectations will be."

Suggestions for Improvement

- Consider including additional opportunities within formative assessments for students to demonstrate their thinking in whatever way is best for them to help teachers ensure that they are attending to students' individual levels and needs.
- Consider adding in support for how teachers could modify instruction based on varying levels of student responses in relation to each of the three dimensions. Providing suggestions for how to tailor instruction based on what responses are received could strengthen the evidence for this criterion.
- Consider providing guidance for how students could use formative assessment opportunities for self-assessment.

III.C. SCORING GUIDANCE

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

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

The reviewers found extensive evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions. Scoring guidance was included for most of the assessment opportunities.

Related evidence includes:

- Expected student responses are frequently provided for the suggested discussion prompts in the Teacher Edition.
- Student "Look and Listen Fors" are provided for all formal sections titled "Assessment Opportunities." This guidance is color coded and includes a dimensional/element numbering. system to provide insight into the elements that students are expected to use. However, the extent to which students are expected to use the elements is unclear. For example:
  - Lesson 1: There is an identified Pre-Assessment Opportunity when students create their own models. "What look/listen for in the moment: Look for students to: use words, pictures, and or symbols to represent a stable star, and the guest star in two separate models. (SEP: 2.3; DCI: ESS1.A.1) indicate some mechanism (e.g. energy transfer, matter changes, or unbalanced forces) for why the guest star will change, while the typical star remains stable. It is not important that this mechanism be accurate. (CCC: 7.1; DCI: ESS1.A.1)" (page 32). It is unlikely that the teacher would see any evidence of students actually using CCC **7.1** in this activity.
  - Lesson 2: "What to look/listen for: Questions that connect to the composition and/or the temperature of the guest star remnants. (SEP: 1.1; DCI: ESS1. A.2) Questions that connect to whether the spectra of a stable star, guest star, or guest star remnants change over time. (SEP: 1.1; CCC: 7.1 DCI: ESS1. A.2) Questions about if/how stars and guest stars change, and why they change. (SEP: 1.1; CCC: 7.1; DCI: ESS1. A.1) Questions about what keeps most stars stable for so long. (SEP: 1.1; CCC: 7.1)" (page 47). It is unlikely that the teacher would see any evidence of students actually using CCC **7.1** in this activity.
  - Lesson 4: "What to look/listen for: Look for students to use the checklist for multiple resources, and only seek to gather information once they have decided a source is credible. (SEP: 8.2, 8.3) Look for students to record ideas from multiple sources they deem credible that are relevant to the question of what causes stars (including our

Sun) to remain stable or become unstable and change? (SEP: 8.2, 8.3; DCI: ESS1. A.1, ESS1. A.4) Students start to gather information about feedback loops (although they may not use the term) within stars between pressure out from fusion and gravity to maintain stability. (SEP: 8.3; CCC: 7.1, 7.3; DCI: ESS1. A.4) Students start to gather information about the types of elements that stars can fuse while remaining stable. (SEP: 8.3; CCC: 7.1; DCI: ESS1. A.4) Students start to gather information about what happens when stars run out of elements they can fuse (burn out) or fuses iron. (SEP: 8.3; CCC: 7.1; DCI: ESS1. A.1, PS1.C.1)" (page 77). It is unlikely that the teacher would see any evidence of students actually using CCC **7.1** in this activity.

- Answer keys are provided for some student handouts and provide a variety of sample responses in the following lessons:
    - Lesson 3: Research Key
    - Lesson 5: Sample student models; Exit Ticket Key
    - Lesson 6: Presentation Rubric
    - Lesson 7: Transfer Task Key
- Lesson 6: A "Presentation Rubric" is provided. The rubric includes elements from all dimensions and provides insight into how to interpret a range of responses.
- Example individual and consensus models are provided. Example student models include a range of student responses.
- Example student answers are included for some lessons. For example:
    - Lesson 3: A Research Key is included for the Planning for Information Tool. The Teacher Note at the top states, "Students may come up with ideas here that will be more salient in future lessons. Don't worry! Validate ideas now and we can come back to them or add them later. You do not need to forecast that we will get to those ideas, but if a question comes up that you will know is relevant later, you can ask students to post them on the DQB" (page 131). Dimensions are not included with this key.
    - Lesson 5: Example student models are included with a range of student responses. "The teacher reference provides examples of what student models may look like and brief suggestions on what feedback to provide students" (page 139). Dimensions are not included with these samples.
    - Lesson 5: A key for the Electronic Exit Ticket is included with the dimensions. Support for teachers to assist students with each question is also included.
    - Lesson 6: An answer key for the Presentation Rubric with the dimensions is included. Ideas to support students and specific look fors are included to support teachers in providing feedback for students.
- Lesson 7: The transfer task includes an answer key with dimensions. However, samples of student models are not included for the first question.

Suggestions for Improvement

- Consider supporting students in interpreting their own progress towards mastery of the targeted elements and the learning performance. Revisions that would allow for a more robust use of the knowledge tracker currently used within the unit by students could be one way to support students in interpreting their own progress.

- Consider providing enough scoring guidance for different levels of student performance in all three dimensions so that teachers would have the information necessary to be able to give targeted feedback to individual students.

III.D. UNBIASED TASK/ITEMS

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

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

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples. Throughout the unit students are presented with text and assessments in an interactive and accessible manner, and vocabulary is grade appropriate. Students are provided with enough context to engage with assessments, and prompts are generally provided in at least two modalities (orally from the teacher and written).

Related evidence includes:

- The representations are fair and unbiased.
- Throughout the unit, students are given a mix of text, visuals, and data tables.
- Throughout the unit, students are asked to respond in a variety of ways: talking about their learning with groups and the class, writing their answers, modeling ideas in a variety of forms, and engaging in gallery walks.
- Throughout the unit, students are provided some flexibility in the modality with which they communicate their understanding. For example:
  - Lesson 4: Students are told they will communicate the information from their research by presenting a poster. Students are not given a choice to present their information with this activity even though the TE has a callout box suggesting they do. The Attending to Equity callout box states, “Allowing students to express their ideas using multiple modalities of representation supports student ownership of their learning by giving students choice, access, and control in navigating their own understanding around science ideas” (page 75).

  - Lesson 6: Students are told they must communicate the information from their research and can choose the modality to present their findings.
- Throughout the unit, students are provided with appropriate text and vocabulary in the supplied readings for scientific and non-scientific terms.
- Readings are provided that have been adapted to students' reading levels.
- In two summative assessments, Lesson 5 and Lesson 7, vocabulary and text volume are grade-level appropriate.
  - Lesson 7 contains graphics and text to scaffold the students to where the information on the task is accessible to the students.
  - Evidence of scaffolding was not located for Lesson 5.
- Lesson 6 is also considered a summative assessment. "In Lesson 6, students present the findings from their research using a medium of their choosing in a timed gallery tour. This research cycle culminates their engagement with obtaining, evaluating, and communicating information within this unit" (page 122). Students are given the opportunity to choose the modality with which to present their information.

Suggestions for Improvement

Consider adding in scaffolds to help ensure that the Lesson 5 Exit Ticket is accessible for all students.

III.E. COHERENT ASSESSMENT SYSTEM

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

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

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. Pre-, formative, summative, and self-assessment types are included in the unit, and the materials provide guidance for how assessments can be used to support students in meeting three-dimensional learning goals. Additionally, the materials explain how different assessment types work together to provide a coherent assessment system.

While multiple examples of each type occur during the unit, evidence of at least one example of each type is provided below.

The teacher materials include an Assessment System Overview, which explains that, "Each OpenSciEd unit includes an assessment system that offers many opportunities for different types of assessments throughout the lessons, including pre-assessment, formative assessment, summative assessment, and student self-assessment. Formative assessments are embedded and called out directly in the lesson plans. Please look for the 'Assessment Icon' in the teacher support boxes to identify places for assessments" (page 122). Examples of assessment measures include:

- Pre-assessment
  - Lesson 1: The Assessment System Overview in the Teacher's Guide states that, "The student work in Lesson 1 available for assessment should be considered a pre-assessment. It is an opportunity to learn more about the ideas your students bring to this unit. Revealing these ideas early on can help you be more strategic in how to build from and leverage student ideas across the unit. The initial model developed in Lesson 1 is a good opportunity to pre-assess student understanding of the structure and scale of stars and the Universe" (page 122). However, not all learning goals for the unit are pre-assessed here.
- Formative Assessment
  - See evidence under Criterion III.B.
- Summative Assessment
  - Lesson 5: The Electronic Exit Ticket is listed as a potential summative assessment opportunity.
  - Lesson 7: The Assessment System Overview states, "At the end of this final lesson, students will have the opportunity to demonstrate their competence with a transfer task about Jupiter and the Sun."
- Self-Assessment
  - Lesson 6: The Assessment System Overview states, "Before and after the research cycle in this lesson, students reflect on their engagement in obtaining, evaluating, and communicating information."
  - The Assessment System Overview provides guidance that states, "This resource is available in the OpenSciEd Teacher Handbook: High School Science. The student self-assessment discussion rubric can be used any time after a discussion to help students reflect on their participation in the class that day. Choose to use this at least once a week or once every other week. Initially, you might give students ideas for what they can try to improve for the next time, such as sentence starters for discussions. As students gain practice and proficiency with discussions, ask for their ideas about how the classroom and small group discussions can be more productive" (page 123). Although this resource is included, teachers may miss this because it is not explicitly called out in the materials. In addition, students are not prompted to assess their progress toward most of the learning goals of the unit.

Suggestions for Improvement

- For formative assessments, see suggestions for Criterion III.B.
- Consider expanding pre-assessment opportunities to provide teachers with information about students' prior levels of understanding in relation to all targeted learning goals.
- Consider revisions that would increase the number of explicit opportunities for students to self-assess their progress toward identified learning goals.
- Consider ensuring a close match between the assessments and assessment targets so that teachers and students can be confident that the assessment system is helping them progress toward the learning goals.

III.F. OPPORTUNITY TO LEARN

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

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

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCCs. However, these opportunities are not currently available for all learning goals in the unit.

Students have multiple opportunities to use the following SEP elements from **Obtaining, Evaluating, and Communicating Information** several times over the module, allowing demonstration of growth if any development occurs.

- *Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.*
    - Lesson 3: Students are provided with the *Obtaining Information Tool* that has been partially pre-filled with variety of vetted sources of information. Students are expected to use these sources to begin their "research cycle."
    - Lesson 4: Students are provided with a blank copy of the *Obtaining Information Tool* and the *Evaluating Sources of Information Tool* to use while conducting additional research cycles.
- *Communicate scientific and/or technical information or ideas (e.g., about phenomena and/or the process of development and the design and performance of a proposed process or system) in multiple formats (i.e., orally, graphically, textually, mathematically).*

- Lesson 4: Students engage in multiple “research cycles” to gather information related to their chosen research question. Students then present their findings to “communicate our ideas with each other as a scientific community.”
- Lesson 6: Students use the *Planning for Communicating Tool* to help support them as they plan to communicate their findings, using a variety of formats, of their third research cycle.

Students have multiple opportunities to use CCC elements from **Stability and Change** during the module, demonstrating their growth.

- *Much of science deals with constructing explanations of how things change and how they remain stable.*
  - Lesson 1, step 9: Students engage in a consensus modeling activity in which they model a “typical” star and a “guest star.” Teacher guidance is provided that states, “Highlight student ideas about stability and change on the consensus model.”
  - Lesson 4, step 2: Students are asked to model a stable star system. Students are then presented with a series of prompts designed to elicit the idea that there are cause and effect feedback loops within a star system.
  - Lesson 5, step 3: Students develop a series of models to “tell the feedback loop story of what keeps some star systems stable and what happens that cause others to change dramatically.”

Students have opportunities to receive feedback from the teacher and peers.

- Lesson 3, step 4: Teacher guidance is provided that states, “Collect Planning for Obtaining Information Tool and Pre-Filled Obtaining Information Tool and provide written feedback to students on their progress so far before next class.”
- Lesson 3. step 7: Teacher guidance is provided that states, “In order to individually assess and provide feedback, collect the individual models at the end of the class. Highlight the connections between matter and energy and the big ideas that students will need to put the pieces together when modeling feedback loops in Lesson 5.”
- Lesson 4, step 7: Teacher guidance is provided that states, “At the end of the class, collect Evaluating sources of Information Tool and Obtaining Information Tool to formatively assess students’ progress and provide written feedback. You may also wish to provide feedback on poster progress, if students have started their posters.” In step 8, guidance is provided that states, “The next day, return the Evaluating Sources of Information Tool and Obtaining Information Tool to students and give them a few minutes to review the feedback.”
- Lesson 5, step 3: Students share their models and provide feedback using the “Gotta-Have-It" checklist. Teacher guidance is provided that states, “Give students a few minutes to make revisions to their models based on peer review.”
- Lesson 5, step 3: Guidance is provided that states, “Collect Feedback Loop modeling to provide written feedback before the next class.”

Suggestions for Improvement

- Consider providing opportunities for students to show their new thinking as a response to feedback they have received from their teachers or peers related to all targeted learning goals.
- Consider providing iterative opportunities for students to perform, get feedback, and perform again for all the learning targets.

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

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

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

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

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

OVERALL SCORING GUIDE

Scoring Guides for Each Category

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

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

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

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)