Investigating Life on the Third Rock
EQuIP Rubric for Science Evaluation

Unit Name: Investigating Life on the Third Rock
Grade: 6-8
Date of Review: October 2018
Overall Rating (N, R, E/I, E): E/I
Category I: NGSS 3D Design Score (0, 1, 2, 3): 2
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 2
Total Score (0-9): 6
Click here to see scoring guidelines

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

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

Summary Comments

Overall, reviewers were impressed with how intentionally this unit supports and requires authentic three-dimensional student learning in a difficult topic for students to connect to their daily lives. This unit works towards a unique bundle of Performance Expectations that authentically link Earth and Space Science to both Life Science and Physical Science. The unit provides the opportunity for students to access the materials from a common starting point in the Beginning Activities simulation and video, engage students in sense-making using the Science and Engineering Practices and Crosscutting Concepts as they develop and use scale models and analyze benefits and limitations of their models in Investigation 1, as well as iterate on using their models to explain phenomenon in the sun, moon, and earth system in Investigation 2. Teacher materials could be deepened to include more specific lesson level guidance for teachers and students about how to use assessments to inform instruction and specific examples and strategies to develop/use student questions about phenomena to link lessons and investigations together, thus increasing unit coherence. *Note that in the feedback below, black text is*

*used for neutral comments or evidence the criterion was met **and purple text is used evidence the criterion was not met.***

Category I. NGSS 3D Design

Score: 2

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: Adequate

The reviewers found adequate evidence that learning is driven by students making sense of phenomena because multiple lesson-level phenomena are connected to the topic of space science. While these lesson-level phenomena are not connected to each other through an anchoring phenomenon, student sense-making is driving the learning within investigation 1, 2, and 3, which is the key aspect of this criterion.

- In the pre-lesson, students watch two videos: Video 1 shows a computer animation of the motion of the solar system; and Video 2 puts the 4.5-billion-year history of the Earth in reference to a 24 hour-clock when describing how life has evolved over time. Students are then asked what questions they are wondering about after watching the two videos. The materials indicate that students are probably wondering about the relationship between the solar system and life on Earth, and that the teacher should facilitate discussion in the classroom to have students share their questions. At the end of discussion, it is the goal to get students to come up with the overall big question for the unit, “How do the solar system and its objects affect life on Earth?” After students come up with the big overall question, they are asked to think about what evidence they would need to answer that question. Each student is asked to come up with two pieces of evidence they would need to answer, “How do the solar system and its objects affect life on Earth?” Students should discuss the evidence they come up with on a chart or the board. Once students have the evidence they think they will need to answer the big question, they are asked to think of questions that they can investigate in class to help them collect the evidence to answer the big question. The materials indicate that the teachers should have students read their two questions to the whole class and have them think about categories into which they could classify the questions brought up.

- Students questions from learning in Investigation 1 do not lead to Investigation 2. Students return to their question board to look for topics they have not found answers to yet.

- Lesson Level Phenomena

- Invest. 1: Some planets are habitable, others are not. Earth is the only known planet with life. What causes this? (Students are introduced to the Kepler Mission and ask questions about what it should look for.)

- Invest. 2.1: The Moon does not always look the same (Students observe the moon for at least 30 days using a moon observation calendar, and students then ask questions about what could cause this - but the same lesson also has them ask what causes day/night sunrise/sunset.)

- Invest. 2.2: [Should be]: Plants have distinct growing seasons - what causes this? The teacher materials expect that students already know what happens to plants over the course of a year (Part A p. 6) Describe what happens to plants over the course of a year--asked to recall.

- Invest. 2.3: Solar and lunar eclipses occur - why? what causes them? what explains their patterns? (Students watch videos of both and record their questions.)

- Invest. 3: "Every time we have looked at a model of the Earth-Moon-Sun system, it has moved in a consistent way. Why do you think the system stays consistent?" They then use a simulation to test ideas about how mass/distance could affect the relationships between the bodies.

From investigation to investigation, students do not make sense of an overarching anchoring phenomenon for the unit. While the unit developers identified an anchoring phenomenon for the unit, it is not used as a phenomenon. It is clear to the student during each lesson how the learning they are doing will help them to better explain a lesson-level phenomenon, but investigations could be independent of one another. In the Unit Coherence document, science topics were referred to as phenomena rather than the observable occurrences that can be explained with the science used as lesson-level phenomena.

- **Unit Coherence Document Anchoring Phenomenon:** The properties of the solar system and its objects affect life on Earth. That is a topic, not a phenomenon.
- "The Goldilocks Zone and models of the solar system explain why Earth is habitable for life" is an explanation, not a phenomenon.
- The lesson-level phenomena link to the larger topic of properties of the solar system and its objects affect life on Earth, but are not explicitly linked to any anchoring phenomena in the teacher materials after each lesson or investigation.
    - Investigation 1: Looking for More Than Porridge (page 8), Teachers are instructed to point out the questions that still need to be answered and focus on the questions about the moon, which is where Investigation 2 is headed. This example illustrates how the investigations are connected topically, not to an anchoring phenomenon.

Suggestions for Improvement

The flow of instruction in the pre-lesson is very student-driven in identifying the investigative questions, which is an excellent and challenging feature. A skilled teacher will be able to follow this and yield the desired results, but an inexperienced teacher may not yet have the capacity to facilitate this level of conversation and yield a high-quality question board. Additional supports, such as suggestions for what to say if students provide answers that are off topic or student samples, would be helpful.

Resources that may help include:
Using Phenomena in NGSS-Designed Lessons and Units: http://stemteachingtools.org/brief/42
NSTA Criteria for Evaluating Phenomena:
http://static.nsta.org/ngss/docs/Criteria%20for%20Evaluating%20a%20Phenomenon.pdf

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: Extensive

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

Science and Engineering Practices (SEPs): **Extensive**
The reviewers found extensive evidence that students have the opportunity to develop and use several SEPs, including **Developing and Using Models**, and **Engaging in Argument from Evidence** throughout the learning.

- The SEP of **Developing and Using Models** is extensively developed and used throughout the unit. In Investigation 1, students observe a video and are asked to describe how the filmmakers modeled the solar system, benefits of using that model and limitations of the model, which is a 3-5 element (page 16). Then, students develop their own models and *evaluate their models*, discuss how they can be *used to make predictions*, and how the model can be *used to describe unobservable mechanisms,* which are 6-8 elements of the SEP (pages 17-18). Throughout Investigation 2, students are identifying and evaluating what they would need to know to make their models better. Students are refining their models based on new evidence from new learning throughout.

- Students are also developing and using the **Engaging in Argument from Evidence** SEP throughout the unit. In Investigation 1, "To hit the grade-level appropriate elemental levels for **Engaging in Argument from Evidence**, students should then compare their arguments with other students out loud, or with a partner. They should also *compare the evidence* they used to their peer's choice of evidence and discuss how they *emphasized similar or different evidence"* (page 7). In Investigation 3, students first write four explanations in CER format and then again compare their arguments based on evidence as they "look for similarities and differences in the arguments produced from their classmates. They are then asked to describe at least one pattern that they saw among all of the data presented" (page 10).

Disciplinary Core Ideas (DCIs): **Extensive**
The reviewers found extensive evidence that students have the opportunity to develop or use the DCI elements in **ESS1.A, ESS1.B, LS1.C,** and **PS2.B** throughout the unit.

- Students are heavily engaged in the earth and space science DCIs for **ESS1.A: The Universe and Its Stars** and **ESS1.B: Earth and the Solar System**. In Investigation 1, Activity B, students are analyzing data on different space objects, which meets the grade appropriate element of **ESS1.B:** *the solar system consists of the Sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the Sun by its gravitational pull on them*. In Investigation 2.1, students are *observing, describing, and predicting and explaining the apparent motion of the sun, moon, and stars in the sky by creating a model* **(ESS1.A).** In Investigation 2.2 (Part C and D) students make connections that *Earth's tilt allows different amount of sunlight on different areas of the Earth throughout the year, causing the seasons* **(ESS1.B)**. Students are creating models in Investigation 2.3 to *explain solar and lunar eclipses and why they don't occur every month* **(ESS1.B)**.

- The developers created a life science DCI connection in Investigation 2.2 (Parts B and D) when students are analyzing data and gathering evidence of what changes in plant life during the year and begin to make connections between amount of sunlight and plant life on earth which is supporting the grade appropriate DCI element *plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use* for **LS1.C**.

- Developers connected the Earth and Space Science DCI **ESS1.B** element that *the solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them* and DCI **PS2.B** element *gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun* in Investigation 3, as students explore how mass and distance affect the motion of objects in our solar system (Part B).

Crosscutting Concepts (CCCs): **Extensive**
The reviewers found extensive evidence that students have the opportunity to develop or use the CCCs of **Systems and System Models** and **Scale, Proportion, and Quantity,** and **Patterns** in this unit as they develop their understanding of the DCIs.

- The unit begins by eliciting student ideas about systems and models (Beginning Activities Lesson, page 7), which gets students thinking visibly on the grade level elements of **Systems and System Models** that *models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy, matter, and information flows within systems. Models are limited in that they only represent certain aspects of the system under study*. In Investigation 1 (Part C.1.c), students are building on their understanding of the elements of Systems and System models as they look at the benefits and limitations of their models (page 16). In Investigation 3, students are using the solar system model to *represent interactions within the system*, another grade appropriate element.

- **Scale, Proportion, and Quantity** is developed and used beginning in Investigation 1 when students are observing data at different scales to study systems that are too large; they are looking at proportional relationships and seeing how things change with scale, which supports the grade appropriate elements (Part C). In Part D of Investigation 1, students are evaluating the system models based on evidence and looking at what may be different based on the scale that

was used. In Investigation 3, students must think through why they chose the "model option instead of a scale option" in their investigation, focusing on the grade band elements that the *observed function of a natural and designed system may change with scale* and *phenomena that can be observed at one scale may not be observable at another scale* (page 20).

- In Investigation 2, students are also developing the CCC of **Patterns** as they analyze data to *identify patterns to explain the cause and effect relationship* of the earth-moon-sun system and moon phases, patterns of moon phases and patterns in moonrise and set times and *evaluating patterns for cause and effect relationships* among objects the solar system (Investigation 2.1 Part A, Investigation 2.2).

Suggestions for Improvement

DCIs

Other than in the assessment rubrics, the intended DCI alignments are not listed, and it may be helpful for the teacher to identify which DCI is in each lesson.

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: Adequate

The reviewers found adequate evidence that student performances integrate elements of the three dimensions in service of figuring out lesson level phenomena. The three dimensions are intentionally used together in the student sensemaking process of figuring out why we can have life on earth, how celestial objects affect our Earth, and what causes the motions of objects in our solar system throughout the unit.

The unit is focused on students developing and using models (SEP) of the Earth, Moon, and Sun System, and using scale (CCC) to represent their understanding of the solar system and the patterns and motions among the objects in the system (DCI).

- In Investigation 1 Part B.3, students explore and explain the questions, "What do we mean by "model" in science? How could scientists use models to help understand systems? and How would scientists use models to help understand the solar system?" The SEP, **Developing and Using Models**, the CCC of **System and System Models**, and the DCIs of **The Universe and Its Stars** and **Earth and the Solar System** are all used together to answer these questions.

- In Investigation 2.1, Part B.3, students **analyze data** (SEP) of the moonrise/set and the sunrise/set (DCI), to **identify patterns** (CCC), and *consider possible causes and effects* (CCC element) to explain their moon observation calendar.

- Investigation 2.1 Part C, students **develop a model** (SEP), consider the **components and interactions of the system** (CCC), and use it to explain the phenomenon of the **moon appearing to change shape** (DCI).

Suggestions for Improvement

The modeling task in Investigation 3 addresses the SEP but does not highlight the CCC as strongly for students as it could. Though the three-dimensional nature of this task is evident in the rubric, no other three-dimensional prompts are provided for the teacher or student. This could easily be marked as extensive if three-dimensional student and teacher prompts were present in this final demonstration of learning about the unit.

Overall, the reviewer team was deeply impressed with how intentional the three-dimensional learning for students was highlighted.

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: Adequate

The reviewers found adequate evidence that lessons fit together coherently to target a set of performance expectations because each lessons' learning builds upon prior lessons and connects with student questions.

- Lesson-level phenomena create a topical storyline that builds toward having an explanation for the overarching question, "How do the Solar System and its objects affect life on Earth?"

- Investigation 2.3 Part A.1, students watch two videos, one of a solar eclipse and one of a lunar eclipse. Students are asked what they noticed and wondered about the two videos. Students are prompted to see what questions they still have. Any new questions can go on the class question board.

- In Investigation 3 "After students complete their revised model, as a class, look at the questions students generated during the opening activity. Have students discuss which questions have been answered already, what evidence the class has gathered to answer the question and note that somehow (move them to new board, place an "x" on them, etc.). If there are still questions that have yet to be answered, you can have students to a small extension activity to find the answers" (page 11).

- At the end of the teacher section in the investigations, instructions say to have students look at the questions generated, discuss what has been answered and the evidence to support those, point out what's still left and move that as the focus (Investigation 2, page 6).

- Investigation 3 starts with "Where did we come from in this unit? Students have just finished learning how the motions of the Earth-Moon-Sun system can explain moon phases, seasons, and eclipses. Students have also just revised their model that explains how the solar system and its objects affects life on Earth for the second time." Then, Investigation 3 gives "Where are we going in this Investigation?" This investigation students will create a model identifying how the components of the Earth-Moon-Sun system (including gravity) interact to explain the system's

consistent motion and construct an argument to support their explanatory model." There is no mention of the students' previous questions from Investigation 2 being used to drive Investigation 3.

Suggestions for Improvement

Though each lessons' learning builds upon prior lessons, the references to student questions only happen when moving to new investigations. In this sequence of instruction, it can appear that student questions are not the motivating factor to move from one lesson to the next, rather, the teacher is generating and providing the next area of inquiry without specific mentions in each lesson. Reviewers recognize that prompts to refer to student questions are mentioned in teacher materials, but a novice teacher would need more guidance and support with instructional techniques and specific examples for how to use student questions to drive the learning. Reviewers agree that the unit would be strengthened if connections to student questions were explicitly made in each lesson, and more importantly, across investigations, rather than just in the overviews.

Additionally, if there were an anchoring unit phenomenon, or suggestion about how to link the learning between Investigations, it would help teachers understand the significance of the lesson sequence. It is unclear how learning is linked other than topically, when the lessons transitioned from the Goldilocks conditions on Earth, to the moon in Investigation 1 and 2. Consider deepening guidance for teachers about how to support students to make sense of the many phenomena across the unit including more teacher materials other than the already included Unit Coherence Document.

Consider reviewing the pre-lesson question board activity and provide and/or utilize questions from that first lesson that students generated to move the learning forward with each step along the way to make sense of a phenomena.

Resources that may help include:
Qualities of a Good Anchor Phenomenon for a Coherent Sequence of Science Lessons:
http://stemteachingtools.org/brief/28

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: Extensive

The reviewers found extensive evidence that links are made across the science domains when appropriate as the unit has intentionally been developed with focus on the Earth and space science (ESS), with connections to life science (LS) and physical science (PS). Reviewers remarked that this is a novel and unique bundling of ESS PEs to include LS. These PEs are used in harmony to motivate student sensemaking when students connect ESS to LS and when students to make connections and observations between the seasons with MS-LS1-6 and MS-ESS1-1.

- Throughout the unit, students use crosscutting concepts and develop their understanding in how, **Systems and System Models** applies to understanding the physics of gravitational

attraction as well as the Earth science concepts of the seasons and phases of the moon and how these affect life on Earth.

- Investigation 2.2 (What's Up with the Seasons) Part E students are asked to draw a model with components and interacts that shows sunlight input, photosynthesis process, and plant growth output: CCC element: Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems.

- Investigation 3, students are using the solar system model to represent interactions within the system, another grade appropriate element.

Suggestions for Improvement
N/A

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

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

The reviewers found adequate evidence that the materials provide grade-appropriate connections to Common Core State Standards (CCSS) in Mathematics, English Language Arts (ELA), and Literacy in History/Social Studies, Science and Technical Subjects because connections are listed in each lesson. Grade-appropriate Common Core ELA standards are called out in every lesson, and appropriate math connections are made in several with teacher support to help students make these connections.

For example, in Investigation 2.3, students engage in CCSS Math 8.G.A.4 and RST.6-8.9 while looking at relative sizes of objects, creating their own eclipse viewer, and revising their own models of the Earth-Moon-Sun system.

Suggestions for Improvement
It would be powerful to identify where and how the CCSS connections are being hit in every lesson. This would support teachers not familiar with CCSS understand the direct connections between all the standards and specific points in the lessons.

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

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

Category II. NGSS Instructional Supports

Score: 2

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

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

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

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world. Reviewers recognize that connecting students home and community is challenging given the astronomy content; yet in both in the unit Pre-Lessons and Investigation 2 students engage with videos and home connections to the Earth-Sun-Moon system as directly as possible to generate compelling lines of student inquiry that come from their experience, community, and/or culture.

- Beginning Activities Lesson: students watch videos and have a shared experience. In Investigation 2.0 Appendix A: The Earth-Sun-Moon system has shaped life on Earth in all cultures, including yours! “Many groups of people have lived and worked, using their understanding of astronomy and their beliefs and explanations about what was observed in the skies. Before widespread use of tools, such as calendars and odometers, the skies were used to keep time, navigate, and guide decisions. Directions: Record what you and your family think about or do during different moon phases, seasons, and eclipses. Do you have any traditions or rituals? Then, research how two different ancient civilizations and/ or cultures view the same ideas Did or do they have any rituals or traditions?”

- In Investigation 2.2, “students will then look at 4 cities around the world and describe how the time of the year affects the amount and intensity of received sunlight. This would be an appropriate place, if time is an issue, to jigsaw the data collection and have students each collect one city’s information and share with their small groups” to make connections to their own lives.

Suggestions for Improvement

Potentially adding guidance to Appendix A: Ancient Civilizations & Cultures & The Moon: Teacher Notes for how to connect students’ questions, prior experiences and diverse backgrounds to the phenomena so that their funds of knowledge are used to drive the lesson and the sense-making or providing STEM Teaching Tool #31 as a resource for teachers unfamiliar with building of student and community interests and expertise.

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

Rating for Criterion II.B. Student Ideas: Adequate

The reviewers found adequate evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas. Students have multiple and varied opportunities to reflect on their thinking, models and writing. Students then go public with their ideas, solicit feedback and make revisions to their initial models and writings. Most feedback is gathered from peers.

- Investigation 1: "Students should then compare their arguments with other students out loud, or with a partner. They should also compare the evidence they used to their peer's choice of evidence and discuss how they emphasized similar or different evidence. This should be structured student-talk time. Below is a resource that has some structured student-talk prompts for students that would be appropriate for this activity. STEM Teaching Tools: Practice Brief 48: How can teachers guide classroom conversations to support students' science learning? Talk Resource Cards" (Part D).
- Investigation 2: Part B.1: Does the moon also rise and set? Is it a similar system as the sun rising and setting? What I think, What my partner thinks, what the class thinks.
- Investigation 2.1 when teacher initials the student plan to make the model is the only documented teacher feedback area. Throughout the rest of the unit it is not evident that the teacher is monitoring for student growth and understanding using the formative assessment opportunities (page 8).

Suggestions for Improvement

It would be helpful to make more explicit where teacher feedback is given to students as most of the unit is focused on peer discussion and reviewing. It is clear where students are writing and revising that writing, but it is not indicated where teachers may be providing concrete feedback in the learning cycle.

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

The reviewers found adequate evidence that the materials identify and build on students' prior learning in all three dimensions because each of the lessons lists the PEs that students should have experienced during prior grades in the "How does this lesson build upon prior Performance Expectations" section, but do not explicitly identify what student learning is expected for all three dimensions.

- Investigation 2.2 includes the PEs and a brief explanation: "Students will be looking at seasons in terms of a plant's life cycle." This lesson brings in ideas of sunlight intensity and duration in different parts of the world and how that affects plant life."
- In Investigation 2.3, the lesson builds student understanding of relative size and scale of different objects in the solar system, especially the Earth, moon, and sun.

Suggestions for Improvement

Consider identifying more explicitly what from each dimension is expected as a prerequisite, based on the lesson level SEPs and CCCs, not just the list of prior PEs (which only mention specific SEP-DCI-CCC combos). With middle school students who haven't experienced NGSS instruction since Kindergarten, it is possible that teachers may need to teach elements of the SEPs, DCIs, or CCCs below the middle school grade band.

Reviewers recognize that though PEs include all three dimensions, it is not explicit what components of the SEPs, DCIs, and CCCs the students should have mastered and how their prior learning will be built upon. This portion of the lessons could easily be developed further with a few sentences so that materials make clear the expected level of proficiency students should have with all three dimensions for the core learning in the unit and provide suggestions for adaptation if students are above or below this level.

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: Adequate

The reviewers found adequate evidence that the materials use scientifically accurate and grade appropriate scientific information because the materials offer quality information about the Earth-Moon-Sun system, eclipses, seasons, and the solar system. This unit uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

- Investigation 3 offers students videos from the History Channel and a Gravity and Orbits simulation.
- Investigation 2 lists a variety of resource links for students to research from at a grade appropriate level.

Suggestions for Improvement

Developers should consider adding possible student misconceptions for each lesson as well as strong support for teachers to clarify potential alternate conceptions that they (or their students) may have with each investigation.

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

i. Appropriate reading, writing, listening, and/or speaking alternatives (e.g., translations, picture support, graphic organizers, etc.) for students who are English language learners, have special needs, or read well below the grade level.
ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.
iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

Rating for Criterion II.E. Differentiated Instruction: Inadequate

The reviewers found inadequate evidence that the materials provide guidance for teachers to support differentiated instruction because, although there are strategies for ELs in the front matter of each lesson, the reviewers did not find any evidence of extra support for students with special needs, students who might be below grade-level, or students struggling academically.

- Each investigation is accompanied by "How Can I Support English Learners?" and "The following chart identifies strategies for Developing and Using Models you can use with students who score at different English proficiency levels on the WIDA ACCESS 2.0 assessment." This chart suggesting guidance is a good starting point for a general classroom.

- In Investigation 2.2 Part B.3, students really look at and analyze the data found from the Sea-WiFS sensor. Developers suggested support includes: "Students should be able to identify many patterns while analyzing all of the data on the website. You can have students share their findings with their small group or have small groups compile their information on whiteboards and do a gallery walk around the room."

- Reviewers recognize the evidence of extension activities for students who have already met the performance expectation found in the unit.
    - At the end of Investigation 3, "If there are still questions that have yet to be answered, you can have students do a small extension activity to find the answers."
    - Students who have extensively met MS-ESS1-2 and MS-PS2-4 could further investigate the relationship between gravitational force and the masses of the interacting objects. Students could collect further data in a simulation such as "Gravity Force" from PhET (https://phet.colorado.edu/en/simulation/gravity-force-lab) and present more data that supports gravitational interactions are attractive and depend on masses on Earth, not just in space.

Suggestions for Improvement

In addition to providing lists of alternate texts and videos, developers could consider how to include differentiation to meet the needs of specific groups such students reading far below grade level, students who are struggling academically, and students who have already met the performance expectation. Strategies such as alternate phenomena, multiple modalities, multiple examples, visual supports, vocabulary scaffolds, and specific sentence stems are some examples of what could be included. When adding these resources considering explaining in the teacher materials how to identify student understanding at that point in the lesson and how the suggested supports will help students demonstrate progress towards understanding the PE's.

Guidance for teachers in the included materials is general and related to ELs with brief extensions mentioned. It would be helpful to include more fleshed out specifics about what the teacher should do in each case.

Consider providing alternatives for articles for multiple reading levels, modified prompts, and differentiated graphic organizers. It would be helpful if the formative assessments were also written explicitly at the place they are being used. Sample student responses and how to support students who are not meeting expectations would help support all teachers with each lesson. A simple addition to support differentiated learning would be including a suggestion for using a text to speech reader as an alternative for additional/supplemental text supports.

Here are some more suggestions on how to scaffold student talk in the classroom:
http://www.ascd.org/publications/books/108035/chapters/procedures-for-classroom-talk.aspx

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

The reviewers found adequate evidence that the materials support teachers in facilitating coherent student learning experiences over time because each investigation is bookended by a "Where did we come from" and "Where are we going" section, but there is not specific guidance for strategies given within investigations or lessons.

- Authors provide a unit outline, overview and document list to support unit coherence. These supporting documents guide teacher understanding of where a unit is going, but do not include specific strategies for linking student engagement across the lessons.
- Investigation 2.2. as students come up with the questions about photosynthesis and plant life throughout the year, teachers should guide students towards looking at the relationship between sunlight and plant life on Earth." It is unclear how the teacher should guide the conversations? What are some questions they could ask to prompt student discussion? What types of answers should they be looking for?

Suggestions for Improvement
Developers could include more specific and direct teacher guidance in the lessons rather than just in the overviews. Consider adding a section about coherence in transition between lessons to refer back to the student questions generated in the pre-lesson with explicit directions that include ways to guide discussion, using student questions. Also consider adding specific "look-fors" with student questions and prompts to help make teachers successful.

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

Rating for Criterion II.G. Scaffolded Differentiation Over Time: Inadequate

The reviewers found inadequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjusts supports over time. The reviewers could not find specific evidence of different levels of support between early lessons and later lessons of a change in how the SEPs are being used from the beginning to the end of the unit in student materials.

Teacher materials advise providing students with less scaffolding, but the student sentence frames and materials do not reflect any changes in support and there was no evidence of specifics in teacher materials about how to gradually use less scaffolding.

- In Beginning Activities Lesson, Part B "teachers may choose to scaffold this activity with students, depending on their students' familiarity with creating models. Suggestions for scaffolds could include:
    - Asking verbal guiding questions while students construct the model
    - "What did we see in the videos that definitely needs to be in our model?" "How would we show that?"
    - Creating a class word or word phrase bank with students (students identify terms)
    - Starting the model with the whole group"

- In Investigation 2 Overview "Teachers can continue to scaffold this modeling activity with their students as they did for the first revised model, but use less supports this time as to put more of the responsibility on the student to make and revise their model" (page 6).

Suggestions for Improvement

Sentence frames are heavy throughout the student materials in investigations and it may be helpful to gradually remove this support as you move through the investigations with accompanying instructional guidance for teachers about how to differentiate and best use the scaffolds to support student development of the SEPs. Consider making multiple student templates with different levels of supports built in so teachers or students can engage at multiple levels of support, for sense-making. A resource to use to look at the development of practices is ***Appendix D***.

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

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

Category III. Monitoring NGSS Student Progress

Score: 2

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

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

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with core ideas and crosscutting concepts to make sense of phenomena because the tasks elicit a range of responses with all three dimensions to make student thinking visible.

- In Investigation 1 Part D, students engage at the element level (in service of explaining that Earth is in the habitable zone for life in the MEL):
  - SEPs:
    - *Develop and/or use a model to predict and/or describe phenomena*
    - *Compare and critique two arguments on the same topic and analyze whether they emphasize similar or different evidence and/or interpretations of facts*
  - CCC: *Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small*
  - DCI: **ESS1.B: Earth and the Solar System -** *The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them* (pages 21-31).

- Investigation 3 Part C engages students in the following elements (in service of explaining the motions of the Earth-Moon-Sun system are consistent):
  - SEPs:
    - *Develop and/or use a model to predict and/or describe phenomena.*
    - *Develop and/or revise a model to show the relationships among variables, including those that are not observable but predict observable phenomena.*
    - *Evaluate limitations of a model for a proposed object or tool.*
  - CCC: *Models are limited in that they only represent certain aspects of the system under study.*
  - DCIs:
    - **ESS1.B: Earth and the Solar System** - *The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.*
    - **ESS1.A: The Universe and Its Stars** - *Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models (pages 22-23).*

Suggestions for Improvement
N/A

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

Rating for Criterion III.B. Formative: Adequate

The reviewers found adequate evidence that the materials embed formative assessment processes throughout that evaluate student learning.

Formative opportunities were explicitly called out in Assessment Opportunities. Suggested resources are linked to help facilitate conversation (ex: Talk Moves) so the teacher can better facilitate the questioning in the discussion, but there was no evidence of student sample responses or suggestions for shifting instruction based on student understandings in the formative assessments. Formative assessments ideally include some specific support for modifying instruction based on student responses, but sample student responses are not provided, and rubrics/teacher materials do not include supports for shifting instruction based on responses elicited from specific tasks.

Some examples of formative assessments identified in the materials include:

- Beginning Activities Lesson Part A: The opening question is a chance for students to show their prior knowledge about the solar system, what it is made up of, and how it moves.
- Beginning Activities Lesson Part B.1: identified by developer as formative assessment (initial model), students are asked to create an initial model to explain how the solar system and its objects affect life on Earth.
- In Investigation 2.3 Formative: Part B.3, students are finding patterns about how the relative size of the butterscotch candy compares to the neon circle in the front of the room.

Suggestions for Improvement

To improve the rating of this criterion, formative assessments should not only include discrete assessment opportunities alone, but also processes to inform and adjust instruction**.** While there is a tendency to think of formative assessments as pre-tests and post-tests, exit tickets, etc., these are not inherently formative nor are they, alone, sufficient to be considered examples of formative assessment as required by this criterion. To be formative, “what does this tell me and what do I do next” have to be addressed. Consider adding to teacher materials where formative assessment is indicated opportunities that include support for next steps.

Developers should consider more support for planning instruction based on formative assessment results. Teacher materials should include teacher instructions about how to inform instruction from these formative assessments. For example, if a student was unable to find a pattern in part B.3, what could a teacher do, reteach or try to help inform their instruction?

Some resources for formative assessment:

http://stemteachingtools.org/brief/18
https://www.ccsso.org/resource-library/revising-definition-formative-assessment
https://www.ccsso.org/resource-library/formative-assessment-examples-practice

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: Inadequate

The reviewers found inadequate evidence in the included rubrics and scoring guidelines to help the teacher interpret student performance for all three dimensions throughout the learning to support teachers in planning instruction or providing ongoing feedback to students. Exemplars student responses are not included, and all major assessment opportunities do not include scoring guidance for teacher or students.

The unit does include helpful three-dimensional rubrics with element level specificity to describe what Mastery, Near Mastery and Approaching responses would include. These rubrics have clear descriptors in each section scoring completed work. These rubrics serve as a useful tool for evaluating progress of student sensemaking in each of the three-dimensions. Though these rubrics do target all three dimensions being assessed, they do not provide guidance for how to interpret student performance along all three dimensions as well as their integration/sense-making. Scoring guidance should support teachers, students, and possibly parents in monitoring student progress toward their ultimate learning goals. Examples of evidence include:

- Investigation 3 What keeps the Earth-Moon-Sun System's Motion Consistent Rubric in provides a provides a three-dimensional scoring rubric for the summative activity (pages 25-26).
- Investigation 2.1 Part C Did find in Investigation 2.1 Part C a "video link to the general idea students should be showing in their models" (page 3)
- Investigation 1, Appendix A provides no guidance for teachers on expected student responses for Part 1 (page 33).
- Investigation 1, Appendix C: Looking for More than Porridge, provides a three-dimensional scoring rubric for the summative activity, no supports for the formative activities in the investigation are included (page 35).

Suggestions for Improvement

Sample student responses for each lesson would be helpful for interpreting student performance. Developers should include more detailed supports for planning instruction based on assessment results. Consider providing a next steps resource that will support teachers with potential instructional follow-ups for students depending on their level of mastery. Consider including guidance to teachers and students about how to address gaps and misconceptions through future instructional experience and other assessment opportunities (explicit coherence in terms of interpreting student progress).

III.D. Unbiased tasks/items: Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

Rating for Criterion III.D. Unbiased Task/Items: Adequate

The reviewers found adequate evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples because the tasks are culturally neutral and provide scaffolds to ensure all students are entering the learning with the background knowledge they need and are given opportunities to respond in a variety of ways to support their sense making.

- The MEL task in Investigation 1 is culturally neutral and provides potential scaffolds to make sure that students have the background they need to be successful with the task (i.e. everyone has shared experiences with the videos of phenomena and Opening Lesson tasks).
- The MEL task also provides a variety of ways for students to convey their answers (e.g. drawing arrows on the MEL diagram, partner talk, short writing, extended writing).
- The MEL's text and vocabulary is grade-band appropriate and matches the targets in the MS standards.

Suggestions for Improvement

To be extensive in this category is to leverage students' funds of knowledge within assessment opportunities. Representations or scenarios that capitalize on the funds of knowledge that students bring with them to the classroom and materials provide clear pathways for students to make connections to their lives beyond the classroom.

III.E. Coherent Assessment system: Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

Rating for Criterion III.E. Coherent Assessment System: Adequate

The reviewers found adequate evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. The unit includes an extensive three-dimensional pre-assessment in the opening activity, multiple opportunities for formative and summative assessment, and multiple opportunities for self-assessment.

- Beginning Activities Lesson pre-assesses all three dimensions as students develop their initial model of the DCIs *(**ESS1.A: The Universe and Its Stars** - Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models)* and *(**ESS1.B: Earth and the Solar System** - The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them)* in Part B.1 and then answer questions to connect the SEP elements (*Ask questions that arise from careful observation of phenomena, models, or unexpected results, to clarify and/or seek additional information)* and *(*Develop and/or use a model to predict and/or describe phenomena), and the CCC element (*Models can be used to represent systems and their interactions—such as inputs, processes and outputs—and energy and matter flows within systems)* (pages 6-7).

- In Investigation 1, students self-assess as the MEL Reflection requires them to assess how confident they are in their argument (page 29).

- In Investigation 3, students reflect on how their ideas have changed over the course of their learning (pages 20-21).

- In Investigation 2, there are several formative assessment opportunities called out in the Overview (page 4).
    - Part B.2: This part shows student understanding of light being reflected off the moon from the sun, not the moon creating its own light.

- Part B.3: Students are using patterns to explain their findings in the moonrise/moonset and sunrise/sunset data.
- Part C.2: Students will bring their Earth-Moon-Sun model idea up to the teacher for approval.
- Part D: Gallery Walk - As students explain their findings on posters around the room, teachers should ask groups clarifying questions about their findings.

- In Investigation 2.3, the final model creation has students developing models (SEP) of the sun-moon-earth system to explain eclipses (DCI) and why they don't happen every month (CCC), integrating all three dimensions to make sense of their learning throughout the investigation. Students then create a final model to connect all learning from each investigation in 2 and a rubric is provided which calls out the three dimensions levels of proficiency (Investigation 2 Overview, page 17).

Suggestions for Improvement

As mentioned in other criteria of this review, formative sample responses as well as suggestions on where/how formative assessment data is informing instruction and how to leverage that data would be helpful to teachers.

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

Rating for Criterion III.F. Opportunity to learn: Adequate

The reviewers found adequate evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of core ideas and crosscutting concepts with the models, CERs, and MELs that are drawn throughout the unit with questions to support all three dimensions in written and oral format. Students are often prompted to reflect and compare their work with others or another source to demonstrate their understandings. These rich reflection and peer review opportunities occur in each investigation. There are many provided rubrics and clear places where teachers could provide feedback, but it is not evident in instructional materials how/when teacher feedback is given to students and how this is used to monitor their understanding as well as inform instruction.

- Investigation 2.1 part D: Sharing results Gallery Walk "As you complete the gallery walk, look at other groups' models. Complete the "Moon Phase Gallery Walk" handout to help you evaluate and critique the models other groups have created.

- Investigation 2.2 all day 'post-it' activity to compare their models to others using the "All Day Post-Its" as described by STEM Teaching Tool Practice Brief 35. Students compare their model to an explanation available online explaining the cause of the seasons. Students then reflect on whether they should change their model based on the new information or if their model already was sufficient.

- In Investigation 1: Looking for More Than Porridge Teacher Notes there are clear directions for what students are expected to do, however there is no guidance for teachers how to use the summative rubric to then inform instruction.

- Investigation 3: After students are satisfied with their CERs, they will post them for other students to look at and compare their responses to. The directions say to post these in an online forum. Teachers could use Learning Management Systems like Google Classroom, Edmodo, Moodle, or Blackboard or they could also use sites like Padlet or other online sites that allow students to post their responses and look at others.

Suggestions for Improvement

Consider adding directions and guidance into the instructional sequence about how teacher feedback is given to students, and how this feedback is then used to inform instruction.

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

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

Overall Score

Category I: NGSS 3D Design Score (0, 1, 2, 3): 2
Category II: NGSS Instructional Supports Score (0, 1, 2, 3): 2
Category III: Monitoring NGSS Student Progress Score (0, 1, 2, 3): 2
Total Score: 6
Overall Score (E, E/I, R, N): E/I

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

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