Stackable Instructionally-embedded Portable Science (SIPS) Assessments Project

Grade 5 Science

Unit 4 Student Profile

Earth and Its Gravitational Force and Motion

September 2023

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SIPS Grade 5 Science Unit 4 Student Profile

The Stackable, instructionally embedded, Portable Science (SIPS) Assessments Unit 4 Student Profile describes what students should know and be able to demonstrate **prior to**, **during**, and at the **culmination** of three-dimensional science instruction in Unit 4 to prepare for new and increasingly sophisticated learning opportunities beyond grade 5. The student profile is intended to build science educators' understanding of the targeted student learning outcomes and how they are situated in the context of year-long instruction to promote and inform the intentional selection of curricular materials and design of instructional opportunities to achieve these outcomes for all students. In addition, the end-of-unit profile can support discussion with students, parents, and guardians about the Unit 4 topic of interest "Earth and its Gravitational Force and Motion" and the knowledge, skills, and abilities to which teaching and opportunities to learn will be based.

The SIPS Assessments Unit 4 student profile provides a description of:

1. The necessary ***prior learning opportunities*** and ***prior knowledge and skills*** that students are expected to have acquired for all three dimensions—Science and Engineering Practices (SEPs), Disciplinary Core Ideas (DCIs), and Crosscutting Concepts (CCCs)—before engaging in Unit 4, "Earth and its Gravitational Force and Motion." These prior learning opportunities and knowledge and skills serve as entry points to the unit to ensure readiness and to foster understanding of new and increasingly sophisticated learning experiences. This section also includes an explanation of how prior learning, knowledge, and skills will be built upon in the unit.
2. The ***knowledge, skills, and abilities students are expected to learn and demonstrate by the end of the unit*** when provided with opportunities to integrate scientific and engineering practices with important disciplinary core ideas and crosscutting concepts to scientifically investigate and understand natural phenomena and solve important science and engineering design problems.
3. The future ***learning experiences that allow students to build from and expand on their learning in the SIPS grade 5 units*** to effectively engage in the SEPs to sense-make using acquired scientific knowledge and understanding of the CCCs in the context of multiple DCIs. This section highlights key connections among important scientific ideas, practices, and concepts that students investigate as they progress from one unit, course, or grade level, to the next.

The following sections describe the prior learning and knowledge, skills, and abilities that students are expected to bring to and acquire by the end of the unit, respectively, and how these knowledge, skills, and abilities prepare students to deepen their science learning in future learning experiences. The content in these sections draws from the dimensional appendices of the NGSS (Appendix E, Appendix F, Appendix G), the performance expectations articulated in the NGSS, A Framework for K12 Science Education, and Stage 1 of the SIPS Unit 4 map.

1. Prior Learning Opportunities

By building familiarity with Unit 3's scientific practices and crosscutting concepts related to Earth's systems and providing possible solutions to problems related to water, Unit 4 allows students to use and extend their understanding and application of these practices and crosscutting concepts to how daily observable patterns on Earth's surface is as a result of the gravitational force and rotation of the planetary objects. In Unit 3, students use the practices of developing and using models, analyzing and interpreting data, using mathematics and computational thinking, defining solutions to a problem, and the crosscutting concepts of scale, proportion, and quantity. In Unit 4 they will be using these same

practices and crosscutting concepts to build their understanding of gravitational force and their influence on the daily and seasonal patterns of physical phenomenon observed on Earth.

Essential prior learning from grades K to 2 and grades 3 and 4 related to the DCIs, CCCs, and SEP are provided in Appendix A.

2. End-of-Unit Learning Outcomes

Measurement targets are narrative descriptions that integrate the DCIs, SEPs, and CCCs into a single statement representing what is to be taught and assessed in each unit. The SIPS Measurement Target for this unit is:

- Students are able to apply Scientific and Engineering Practices with emphasis on supporting an argument using data represented in graphical displays related to the scale of the universe relative to Earth and daily and seasonal patterns of observed physical phenomena on Earth both as a result of its place in the solar system and the effects of gravitational forces.

By engaging in this unit, students further deepen their knowledge of the direction of Earth's gravitational forces and how distance from the Earth influences the brightness of the sun and stars. They also learn about how the rotation of the Earth and moon influences the daily patterns of physical phenomena. In this unit, there is significant overlap and synergy between the DCI and CCC dimensions, where patterns reveal that the Earth's gravitational force is always directed downwards while systems and system models and cause and effect show how the Earth's rotation causes differences in the amount of sun that reaches a particular physical location. Similarly, the SEPs allow students to construct explanations, use mathematical and computational thinking, and consider other evidence to develop models and explanations around Earth's spin on its axis, its distance from the sun and other stars, and understand what causes day and night.

Descriptions of the specific learning expectations associated with each dimension are elaborated below.

DCI

The Grade 5 Unit 4 topic, "Earth and its Gravitational Force and Motion" organizes three performance expectations that together enable the development and use of models that explain how Earth's spin is related to how much sunlight is received in any location and how Earth's gravitational force is always directed downwards. Also, through the use of mathematical and computational thinking, students can show how the distance of the Earth from the sun and stars influences their brightness. In working with these disciplinary core ideas, students are positioned to understand physical phenomena such as day and night and the brightness of the stars in the sky.

CCC

Over the course of Unit 4, students identify and represent patterns, especially as they relate to how Earth's gravitational force is always directed down and how the amount of sun received in any location is related to Earth's spin. Students also make use of systems and system models in how Earth spins around its axis and influences the amount of daylight. In support of these crosscutting concepts, students gain experience with cause/effect relationships that they encounter while understanding the physical phenomenon and how they are experienced in different locations on Earth.

SEP

Over the course of Unit 4, students gain experience and practice with constructing explanations, engaging in arguments from evidence, developing models, and using mathematical and computational thinking. When engaging in arguments from evidence and constructing explanations, they consider why some stars are brighter than others and why shadows are of different lengths during different times of the day. They also use models to understand how Earth spins on its axis and how its rotation around the sun influences day-to-day patterns. In support of these models and resulting design solutions, students will gain experience in mathematical and computational thinking to understand the relationship between the distance of the Earth from the sun and other stars in relation to their brightness.

3. Connections to Future Learning Opportunities

DCI

Unit 4 focuses extensively on understanding the direction of Earth's gravitational force, how the distance of the Earth from the sun and stars influences their brightness, and Earth's spin day-to-day patterns. Students' learning and understanding increase in sophistication beyond grade 5 where students extend their knowledge to understand that there is a gravitational force between any two masses, but it is very small except when one or both objects have large masses—for example, Earth and the sun. The knowledge they obtain about the brightness of stars in relation to Earth's distance is developed further after grade 5 where they are introduced to observing patterns of the apparent motion of the sun, the moon, and stars in the sky. Also, learning about Earth's spins prepares them to learn more about other solar system components and how they are held in orbit around the sun by its gravitational pull on them.

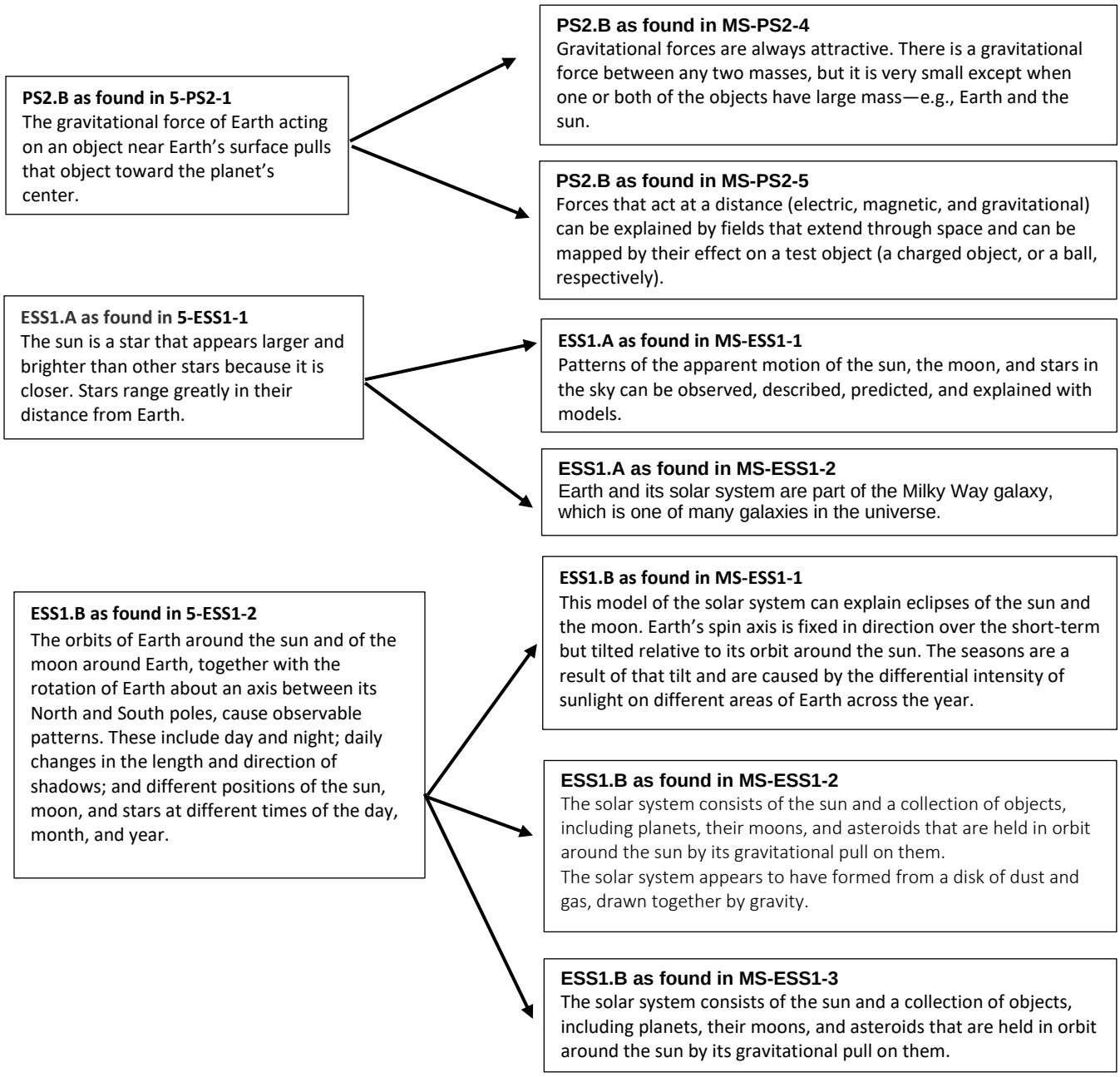
CCC

Unit 4 CCCs focus on using Cause and Effect, Patterns, and Systems and System Models to describe how Earth's spin causes day and night and understand how its gravitation force is always directed downwards. In future middle school learning experiences related to Earth's gravitational force and motion, students will continue to understand how models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems. (MS-PS4-1)

SEP

Unit 4 SEPs focus predominantly on engaging in arguments from evidence and analyzing and interpreting data. Additional SEPs are using mathematical and computational thinking, developing and using models, and constructing explanations and designing solutions. Students visit these practices in their future learning experiences related to Earth's gravitational force and motion by developing and using models to describe phenomena (MS-ESS2-1). They analyze and interpret data to determine similarities and differences in findings. (MS-ESS1-3). They also construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem (MS-PS2-4).

Grade 5 DCIs **DCI Progression in Later Grades**



Appendix A. DCI, CCC, and SEP Prior Learning Opportunities

DCIs – PS2.B, ESS1.A, ESS1.B (from NGSS Appendix E: DCI Progression within NGSS)

- **Prior Learning from K-2** (NRC Framework):
    - When objects touch or collide, they push on one another and can change motion or shape.
    - Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted. At night one can see the light coming from many stars with the naked eye, but telescopes make it possible to see many more and to observe them and the moon and planets in greater detail.
    - Seasonal patterns of sunrise and sunset can be observed, described, and predicted.
- **Prior learning from this grade band (e.g., Grades 3 & 4):**
    - Minimal/ Not Applicable

CCC – Systems and System Models

- **Prior learning from K-2:** Students develop experience describing organisms (and other systems) in terms of their parts and considering how the parts work together to achieve a desirable goal for the organism (or system). [Appendix G]
    - In K-ESS3-1, students work with modeling a system in which multiple plants and animals live in the same area and can satisfy their needs.
- **Prior learning from this grade band (e.g., Grades 3 & 4):** Students continue developing experience with considering systems in terms of their parts, with an additional emphasis on the idea that some behaviors of the system are enabled by the functioning of multiple parts working together. [Appendix G]
    - In 3-LS4-4, students work with the idea that the plants and animals living in an ecosystem may be affected when the environment changes. In 4-LS1-1 students interrogate the functioning of plants (and/or animals) in terms of the organisms' structures that enable the activity of the larger system (i.e., the organism).

CCC – Cause and Effect

- **Prior learning from K-2:** Students learn that when events take place they can be traced back to patterns with observable and testable causes. [Appendix G]
    - In 1-PS4-3, students plan and investigate to determine the effect of placing objects made with different materials in the path of a beam of light.
- **Prior learning from this grade band (e.g., Grades 3 & 4):** Students continue developing experience with test causal relationships on a routine basis and using the outcomes to explain change. At this stage, they are able to understand that not all events that occur together represent cause-and-effect relationships. [Appendix G]

- In 4-ESS2-1, students make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

CCC – Patterns

- **Prior learning from K-2:** Students recognize that patterns in both models and their natural world can be observed and used as evidence as they explore phenomena. [Appendix G]
  - In 1-ESS1-1, students use observations of the sun, moon, and stars to describe patterns that can be predicted.
- **Prior learning from this grade band (e.g., Grades 3 & 4):** Students continue to develop their understanding of patterns as they compare, contrast, sort, classify, and eventually make predictions based on their understanding of models and their natural world. [Appendix G]
  - In 4-PS4-1, students develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.

SEP – Developing and Using Models

- **Prior learning from K-2:** Students develop a basic understanding of a model as a representation of the thing (e.g., an object, event, or process), rather than the thing itself. They also gain experience in comparing and developing different models. [Appendix G]
  - Two PEs (K-ESS3-1 and 2-ESS2-2) are focused on using or developing to understand more about the Earth.
- **Prior learning from this grade band (e.g., Grades 3 & 4**): Students continue developing their modeling skills and abilities by developing and revising different types of models, along with beginning to consider that models can have limitations. [Appendix G]
  - Three PEs (5-ESS2-1 and 5-PS3-1) focus on developing models to learn more about the Earth and/or the Sun.

SEP – Using Mathematics and Computational Thinking

- **Prior learning from K-2:** Students may have had opportunities to recognize that mathematics can be used to describe the natural and designed world(s). More specifically, students should be able to:
  - Decide when to use qualitative vs. quantitative data.
  - Use counting and numbers to identify and describe patterns in the natural and designed world(s).
  - Describe, measure, and/or compare quantitative attributes of different objects and display the data using simple graphs.
  - Use quantitative data to compare two alternative solutions to a problem.
  - However, there is no PE in K-2 that ever uses this SEP; its first introduction is in Grade 5. Therefore, it is likely that students will have minimal or no exposure to formal learning of this SEP prior to Grade 5, Unit 1.

- **Prior learning from this grade band (e.g., Grades 3 & 4 and/or prior SIPS G5 units):** During grades 3-5 students are expected to extend quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions.
    - One PE (5-ESS2-2) asks students to use graphs to obtain evidence and understand more about the Earth.

SEP – Constructing Explanations and Designing Solutions

- **Prior learning from K-2:** Students are expected to have had opportunities to design multiple simple solutions to a problem associated with wind or water and its impact on the shape of the land.
    - Two PEs (2-ESS-1 and 2-ESS-2-2) ask students to use evidence or find solutions aimed at understanding more about the Earth.
- **Prior learning from this grade band (e.g., Grades 3 & 4 and/or prior SIPS G5 units):** During grades 3-5 students are expected to include investigations that design solutions to problems using appropriate information.
    - Four PEs (4-PS3-1, 4-ESS1-1, 4-ESS3-2, and 3-LS3-1) ask students to use evidence to construct an explanation about the motion of an object and/or understand more about the Earth.

SEP – Engaging in Argument from Evidence

- **Prior learning from K-2:** Students develop a beginning understanding that arguments must be supported by evidence, evidence in support (or in contradiction) of an argument can be evaluated, and evidence can be relevant or irrelevant to the specific claim/question. [Appendix F]
    - One PE (3-LS4-4) asks students to make a claim about changes to the environment which may include seasonal changes.
- **Prior learning from this grade band (e.g., Grades 3 & 4):** Students continue developing their argumentation skills and abilities by constructing arguments, supporting those arguments with evidence, and forming an argument to critique an explanation or model. [Appendix F]
    - Two PEs (3-LS4-4 and 3-ESS3-1) ask students to make a claim about changes to the environment which may include seasonal changes.

SEP – Analyzing and Interpreting Data

- **Prior learning from K-2:** Students use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) to answer scientific questions and solve problems. [Appendix F]
    - One PE (K-ESS2-2) focuses on constructing an argument to understand more about human impacts on the Earth.
- **Prior learning from this grade band (e.g., Grades 3 & 4):** Students continue analyzing and interpreting data to make sense of phenomena, using logical reasoning, mathematics, and/or computation. [Appendix F]

- Two PEs (3-LS4-4, 3-ESS3-1) focus on making claims about changes related to understanding Earth.