Mini-Map for SCI.EE.12.ESS.SolSys-2

Subject: Science
Earth and Space Science (ESS)
Grade band: 9–12

Grade-Level Expectation

DLM Essential Element	DLM Disciplinary Core Idea Family[1]	Framework Disciplinary Core Ideas
SCI.EE.12.ESS.SolSys-2 Gather data to determine the relationship between the intensity and directness of sunlight reaching Earth's surface and seasonal temperature patterns.	Earth and Space Science – Earth in the Solar System	ESS1.A: The Universe and Its Stars ESS1.B: Earth and the Solar System PS3.B: Conservation of Energy and Energy Transfer

[1] DLM Science Essential Elements organize Disciplinary Core Ideas (defined in the *Framework for K-12 Science Education*) into DCI families. By combining similar concepts within a domain, science content from the general education standards is reduced in depth, breadth, and complexity to provide access for students that qualify for the DLM alternate assessment.

Linkage Level Descriptions

Initial Precursor	Distal Precursor	Proximal Precursor	Target[2]
Identify sequences, processes, and patterns that occur in the natural world.	Use information from a representation of the Earth-Sun system to relate the cycles of days, nights, seasons, and years (i.e., repeating patterns over various units of time) to Earth's rotation and revolution.	Use data and a model of the Earth-Sun system to specify the relationships between Earth's tilted axis, directness of the Sun's light that reaches the surface of a particular area of Earth, and the warmth and temperatures experienced in that area.	Use data and a model of the Earth-Sun system to explain the causal relationships between the location of Earth in its orbit, the orientation of Earth's axis in relation to the Sun (i.e., tilt), the directness and intensity of sunlight reaching Earth's surface, and seasonal temperature patterns.

[2] The target linkage level description is a measurement target that describes the expectations (content and performance) of the Essential Element for assessment purposes.

Essential Element Three Dimensions

Each Essential Element is defined in the three dimensions described in the *Framework for K-12 Science Education*: disciplinary core ideas (DCIs), science and engineering practices (SEPs), and crosscutting concepts (CCCs). The table below lists the details of each dimension from the individual DLM Essential Element descriptions, with color-coding of dimensions corresponding to the Next Generation Science Standards (NGSS). The first row (in blue) lists the SEP(s) used to construct the Essential Element and describes ways each SEP could be incorporated. The second row (in orange) describes the science concepts within the DCI family related to this Essential Element. The third row (in green) lists the CCC(s) associated with the Essential Element and explains how each might be incorporated in the grade band (quoted from NSTA, 2013, matrix of CCCs). Note that the SEP is presented first here (rather than second, as it is in the full list of Essential Elements) to reflect the emphasis on practices in instruction and across the linkage levels. The final row (in white) includes examples of how the three dimensions could work together to support instruction for the Essential Element. These examples provide ideas for integrating the dimensions and are not exhaustive, nor are they intended to limit instruction.

Science and Engineering Practices	**Developing and Using Models:** Modeling in grades 9–12 builds on K–8 experiences and progresses to developing, using, and evaluating models (e.g., maps, diagram, drawing, physical replica, diorama, graphs, dramatization, storyboard) that represent relationships, events, and systems in the natural world. • Develop, use, and evaluate models to describe relationships between variables and components of a system. • Use models to construct and evaluate explanations in the natural world. **Planning and Carrying Out Investigations:** Planning and carrying out investigations in grades 9–12 builds on K–8 experiences and progresses to gathering and analyzing data in an investigation to evaluate claims and design solutions. • Manipulate variables and collect data to serve as evidence for claims about the natural world. • Gather and use data to inform the improvement of a design solution. **Analyzing and Interpreting Data:** Analyzing data in grades 9–12 builds on K–8 experiences and progresses to analyzing and evaluating to support explanations about relationships and solutions to problems in the natural world. • Represent and analyze data to determine and describe relationships between variables. • Use data to construct and evaluate arguments. • Analyze data to design and evaluate solutions to problems.

Disciplinary Core Ideas	**Earth in the Solar System** • Through sunlight, energy is transferred from the Sun to Earth (see SCI.EE.12.ESS.SolSys-1). • As Earth orbits the Sun, Earth's tilt in relation to the Sun (toward or away from the Sun) results in seasonal temperature patterns. • The seasonal temperature patterns are a result of the differential intensity of sunlight on different areas of Earth across the year.
Crosscutting Concepts	**Patterns**: Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them. • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena. • Classifications or explanations used at one scale may fail or need revision when information from smaller or larger scales is introduced; thus requiring improved investigations and experiments. • Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system. • Mathematical representations are needed to identify some patterns. • Empirical evidence is needed to identify patterns. **Cause and Effect: Mechanism and Explanation**: Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering. • Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. • Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system. • Systems can be designed to cause a desired effect. • Changes in systems may have various causes that may not have equal effects. **Systems and System Models**: A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems. • Systems can be designed to do specific tasks. • When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.

	• Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions—including energy, matter, and information flows—within and between systems at different scales. • Models can be used to predict the behavior of a system, but these predictions have limited precision and reliability due to the assumptions and approximations inherent in models.
How three dimensions support instruction for this Essential Element	Patterns in data can help students understand the solar system and the connection between the amount of sunlight that reaches Earth's surface and Earth's seasonal temperature. For example, students can collect quantitative and qualitative data about the Sun's light energy and seasonal temperature patterns. They can then use the data to support several claims, such as the idea that energy is transferred from the Sun to the Earth through sunlight and that seasonal temperature patterns are caused by variations in the intensity of sunlight in different parts of the Earth. Students can use solar system models to collect data to make claims about cause-and-effect relationships between the Earth's orbit around the Sun, the Earth's tilt, and seasonal temperature patterns. For example, students can explain that, for a particular place on Earth, the Earth's tilt and location in its orbit causes less sunlight and colder temperatures at certain times of year and more sunlight and warmer temperatures at other times of year. Concepts of systems and system models can be incorporated through physical and mathematical (data) models used to understand the solar system. Using models and data, students can build a deeper understanding of the relationship between Earth's tilt, seasonal temperatures, intensity and directness of sunlight, and sunlight's role in transferring energy from the Sun to Earth.

Instructional Resources

Resources
Learning modules and additional science instructional resources can be found at https://www.dlmpd.com/science/
A glossary defining key science terms found in the Essential Elements can be found at DLM Glossary for Science Learning Maps.

Link to Text-Only Map

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