Alignment to the PA STEELS Standards

The mySci *Using Our Resources Wisely* unit was designed for the Next Generation Science Standards (NGSS) and throughout the unit there are indications of NGSS Performance Expectations. The unit is also aligned to the Pennsylvania Science, Technology & Engineering, Environmental Literacy and Sustainability (STEELS) Standards[1]. The targeted performance expectations for this unit from both the NGSS and STEELS standards are shown in the tables below.

STEELS Performance Expectations Addressed	
3.3.4.D Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	3.3.5.D Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

STEELS Performance Expectations Partially Addressed	
3.3.5.E Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	3.4.3-5.A Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.**
3.5.3-5.M Demonstrate essential skills of the engineering design process.*	3.3.5.C Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
3.5.3-5.P Evaluate the strengths and weakness of existing design solutions including their own solutions.*	3.2.4.B Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

*The PA Technology and Engineering standard is partially aligned to the claimed NGSS ETS performance expectation for this unit.
** The PA Environmental Literacy and Sustainability standard is partially aligned to the claimed NGSS ESS performance expectation for this unit.

Color Coding for the Three Dimensions

The mySci *Using Our Resources Wisely* unit uses NGSS color coding to indicate specific connections to each of the three dimensions. The PA STEELS standards use different colors for the three dimensions. The colors used in both standards to refer to the three dimensions are below.

Color coding used for the three dimensions of the NGSS standards	**Color coding used for the three dimensions of the STEELS standards**
Orange text highlights connections to DCIs (**Disciplinary Core Ideas**)	**Blue text** highlights connections to DCIs (**Disciplinary Core Ideas**)
Blue text highlights connections to the SEPs (**Science and Engineering Practices**)	**Green text** highlights connections to the SEPs (**Science and Engineering Practices**)
Green text highlights connections to the CCCs (**Cross-Cutting Concepts**)	**Purple text** highlights connections to the CCCs (**Cross-Cutting Concepts**)

[1] Alignment is based on mySci's NGSS claims and not an in-depth evaluation for STEELS standards.

The purpose of this unit is not to be used in a PA classroom, but rather to illustrate the shifts required by STEELS. With strong science, engineering, and environment connections, it represents the integrated nature of the Pennsylvania STEELS standards while showcasing strong curriculum-based system of assessments.

mySci inspiring the next generation of scientists

Earth and Space Systems:
Natural Resources, Earth Systems, Renewable and Non-Renewable Energy, Human Impacts

Teacher Guide

mySci **Unit 22**:

Using Our Resources Wisely

Washington University in St. Louis
Institute for School Partnership

Bayer Fund

HIGH QUALITY NGSS DESIGN
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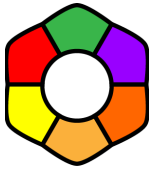
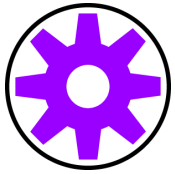
Table of Contents

mySci Symbols Key

 Indicates an opportunity for students to write	 Indicates an opportunity for assessment	 Indicates an opportunity to employ a driving question board
 Indicates an opportunity for the teacher to make a chart	 Indicates an opportunity to attend to equity and inclusion	 Indicates appropriate time to administer the post assessment
 Indicates an opportunity for reading	 Indicates an opportunity to differentiate instruction	 Indicates link to a teacher facing mySci tutorial explaining how to set up the activity for students
 Indicates an opportunity for discourse	 Indicates a key science idea	 Indicates a multimedia resource

Unit 22: Quick View **Using Our Resources Wisely**

ANCHORING PROBLEM:

We need farms to grow food, but the process of producing food for all of us can harm Earth systems.

DRIVING QUESTIONS:

How are farms part of Earth's systems?
How does our use of natural resources on farms affect Earth's systems?
How can farmers use resources wisely to protect Earth's systems?

These questions are provided for you as model driving questions to support categorizing individual student questions and organize the learning progression. Each section is designed to intentionally build toward defining the anchoring problem and designing a solution. You can use these questions to guide your instruction, however, you are encouraged to adapt these questions using the language you develop with your students.

Throughout mySci Units color coding is used to call out specific connections to each of the 3 dimensions of the NGSS standards:

Orange text highlights connections to DCIs (Disciplinary Core Ideas)

Blue text highlights connections to the SEPs (Science and Engineering Practices)

Green text highlights connections to the CCCs (Cross-Cutting Concepts)

STORYLINE

In this unit, students will **make sense of Earth's systems and natural resources, ways that humans use natural resources, human impacts on Earth systems, and how humans can change behaviors to reduce impacts on the environment.**

This unit **intentionally develops the Crosscutting Concept of System and System Models and also uses Scale, Proportion, and Quantity and Energy and Matter for sensemaking**.

This unit **intentionally develops the Science and Engineering Practices of Developing and Using Models and Obtaining, Evaluating, and Communicating Information.**

The unit also **incorporates Using Mathematical and Computational Thinking, Constructing Explanations and Designing Solutions, and Planning and Carrying Out Investigations for sensemaking.**

1. First, students will explore the four Earth systems (hydrosphere, biosphere, atmosphere, and geosphere) and learn how these systems interact.

2. Next, students will learn about natural resources and how humans use them for things like energy, food, and shelter. They will investigate some of the impacts of using natural resources, including the effects of fossil fuel consumption. Students will also examine the hydrosphere in detail, including the distribution of water on Earth. They will learn that water is a limited resource, and the amount and quality of available water can be affected by human activities.

3. Finally, they will learn about strategies humans can use to decrease our impact on the environment. They will examine a case study of an island in Denmark that changed from using non-renewable to renewable energies and then engage in a design challenge to design, build, test, and refine a wind turbine to perform a specific task. Students will also consider how farms can repurpose animal waste to generate energy using biodigesters.

Unit 22: Sections Quick View

Section 1 **How are farms part of Earth's systems?**	Section 2 **How does our use of natural resources on farms affect Earth's systems?**	Section 3 **How can farmers use resources wisely to protect Earth's systems?**
Total time: 6 days LESSON 1 **How can we describe the different parts of the Earth?** *(3 days)* LESSON 2 **How do Earth's systems interact?** *(3 days)*	*Total time: 11 days* LESSON 3 **What are natural resources and how do humans use them?** *(3 days)* LESSON 4 **How does our use of fossil fuels affect Earth's systems?** *(3 days)* LESSON 5 **How does our use of water affect Earth's systems?** *(3 days)* LESSON 6 **How does animal waste affect the environment, and what can we do about it?** *(2 days)*	*Total time: 9 days* LESSON 7 **How can people use resources in a way that is less harmful to the Earth?** *(3 days)* LESSON 8 **How can we use farms to harness wind energy?** *(3 days)* LESSON 9 **How can farms make better use of animal waste?** *(3 days)*

Links to Resources for this Unit

SECTION 1 SLIDE DECK **SECTION 2 SLIDE DECK**

SECTION 3 SLIDE DECK

PARENT/GUARDIAN LETTER

English Version Spanish Version

STUDENT JOURNAL:

Digital Student Journal Answer Key

Print Student Journal Answer Key

ASSESSMENT DOCS:

Post Assessment Answer Key

LITERACY LINKS:

Epic Booklist Unit 22

Quizlet Unit 22

Printable Glossary

Google Slide Vocabulary Cards English

Google Slide Vocabulary Cards English/Spanish

APPENDICES:

Teacher Background Information: Appendix A

Read-Aloud Guides: Appendix B

Handouts/Teacher Pages: Appendix C

NGSS/MLS: Appendix D

Safety Guidelines: Appendix E

Performance Expectations Addressed

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
3-5-ETS1- 3. (5.ETS1.C.1) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5-ESS2-2. (5.ESS2.C.1) Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Performance Expectations Partially Addressed

5-ESS3-1. (5.ESS3.C.1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5-ETS1- 2. (5.ETS1.B.1) Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ESS2-1. (5.ESS2.A.1) Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
4-PS3-2.(4.PS3.B.1) Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Unit 22: **Fast Track** Pacing Guide

Unit 22 Fast Track Pacing Guide

These suggestions can be used if you do not have the full amount of time required to dedicate to the whole unit.

Lesson	How to Adapt
Lesson 1	- Explore: Omit going outside.. - Elaborate: Only show one video, or shorten the length of each video. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 2	- Explore: Use the virtual adaptation of the activity to reduce setup time. - Explain: Omit the Crash Course Kids videos. - Elaborate: Only show one video, or shorten the length of each video. Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 3	- Explore: Omit comparing and sorting the self-documentation data, and only do the class chart about it. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 4	- Explore: Omit the student choice research and only do the asthma research. Alternatively, skip the asthma research and allow for student choice. - Explain: Based on what you omitted in the Explore section, only do one cause and effect sphere interaction activity. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 5	- Omit all portions except for the Explore graduated cylinder, graphing activity, and development of a claim.
Lesson 6	- Keep as is.
Lesson 7	- Elaborate: Omit returning to the model. Students will revise the model again in Lesson 9.
Lesson 8	- Explain: Only have students draw their model and how energy is transferred. Omit drawing an actual wind turbine for comparision. - Elaborate: Read The Boy Who Harnessed the Wind or watch the video.
Lesson 9	- Keep as is.

Lesson 2: Summary

How do Earth's systems interact?

Time: 3 days

Learning Targets

Use models to explain the complex interactions between Earth systems . Revise a model to show the interactions of Earth systems on a farm.

Summary

- In the last lesson, students identified the different systems of Earth and gave examples of each. They created an initial model of a farm that included the parts of the farm and the systems they are part of.
- In this lesson, they will use different models to investigate how Earth systems interact with one another.
- **They figure out that different Earth systems interact and that the interaction of one Earth system can affect the function of another Earth system. Similar to the natural world, the Earth systems present on a farm interact.**
- In the next lesson, students will learn about natural resources and how humans use them.

Building Towards

5-ESS2-1. (5.ESS2.A.1)

NGSS 3-Dimensions:

ESS2.A: Earth Materials and Systems

Developing and Using Models System and System Models

Lesson 2: Five E Quick View	
ENGAGE	Students co-construct an initial model showing how different parts of the environment interact.
EXPLORE	Students use a model to explore how systems interact on Earth.
EXPLAIN	Students use a model to explain how systems interact on Earth.
ELABORATE	Students refine a model of a farm and illustrate the different Earth systems interactions on it.
EVALUATE	Students evaluate each other's farm models and give feedback.

Lesson 2: Prep List

Inside mySci kit you will find:	Items you must supply:	Preparation:
20 clothespins 20 interaction cards String Index cards	Chart paper Student devices	Lesson 2 Student Journal pages or Printed Student Journals

Literacy Connections	Remote Learning
Key Vocabulary **system**: a group of related parts that function together as a whole **interact:** have an effect on each other **Supplemental Reading Resources** Learn About Earth's Spheres	**Interactive & Mini Lesson Videos** How Does the Water Cycle Involve All of Earth's Systems? Mini-Lesson **Hands-on at Home Suggestions** Have students look for evidence of system interactions in their yard or neighborhood.

L2 – Five E Lesson Plan

ENGAGE

Students co-construct an initial model showing how different parts of the environment interact.

Begin the lesson by revisiting the Driving Question Board. Highlight questions connected to the learning goals of this lesson by calling attention to questions about **the interactions between Earth's systems**. If no questions directly relate, use prompts to build on student questions, supporting them to think about how the different parts of their school environment or a farm might interact.

Say to students:

- *Today's activity will support us in answering this question (*ex: How do we make electricity using dams?*). By answering this question, we will be able to better understand why there is a dam in Glen Canyon.*

Say to students:

Say to students:

- *We are trying to figure out how farms are part of Earth's systems in order to address the anchoring problem that producing food uses a lot of resources and that can harm Earth's systems. In the previous lesson, we described the different parts of a farm environment. We considered what Earth systems these things were part of.*

Have students name the Earth systems they worked on in the previous lesson (hydrosphere, geosphere, biosphere, and atmosphere). They can refer back to their models to help them remember the names of the systems. Write them on the board or chart paper.

Ask students:

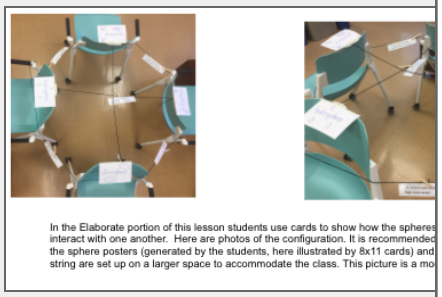
- *How do you think the different Earth systems interact with each other?*
- *Can you give an example from something you have observed in your life?*

	Allow students to Turn and Talk, then share a few answers with the whole class.

EXPLORE

Students use a model to explain how systems interact on Earth.

Teaching Tip: Example of possible system interactions: Fast flowing water erodes rocks (hydro/geo). The water is the cause, and erosion is the effect. Water vapor creates clouds (atmo/hydro). Water vapor is part of the atmosphere, and when it condenses to form clouds, water drops are part of the hydrosphere. Plants use carbon dioxide and give off oxygen. (bio/atmo). The plants are part of the biosphere, and the oxygen they give off is part of the atmosphere.	Say to students: ▸ *Let's explore ways that the systems of the Earth interact with each other. We're going to look at examples of things that happen on our planet. Each group will decide which systems are interacting, and pin the card on the string that links the two systems. Then, we will look at what other groups decided and ask questions about why they made those choices.* Label the walls, chairs or desks: Atmosphere, Biosphere, Hydrosphere, Geosphere using the index cards. Tape a string between each of the four walls, chairs, or desks at the site of the posters, so that each sphere is connected to every other sphere (it will look like a box with an x in it — six pieces of string). Explain that each student or group will get cards that show spheres interacting, and they should clip it on the correct string with the clothespin you will give them. To facilitate student discussions about the cards, as you walk around you can ask: ▸ *What interactions do you see happening in your cards?* ▸ *How do you know those interactions are taking place?* ▸ *Which string do you think this card should go on? Why?* If students are struggling, use the examples in the Teaching Tip to support them. Pass out Interaction Cards and clothespins to the students. Have the students use a clothespin to clip the interactions on the correct strings.



Tutorial

Here is a teacher tutorial for this activity. You can also do this activity virtually using the Earth Systems Interaction game.

EXPLAIN

Students use a model to explain how water moves through and influences systems on Earth.

Teaching Tip:
If you teach Unit 23 "Our Place in the Universe" first, this will be a review for your students. If they do not remember, you can remind them by giving them an example from Unit 23. One example could be our solar system, that is composed of the different parts including the planets, moons, and the sun.

Once students have placed their card, have each student or group share their card, explain which systems are interacting, and the evidence that supports why they think that. Give students time to ask questions and make alternative claims about which spheres are interacting. To support students to do this, consider using: Conversational Support for Sharing and Expanding on Each Other's Ideas from STEM Teaching Tools.

Now is a good time to introduce or review* what a **system** is with students – a group of related parts that function together as a whole. You may ask them what they think a system is, and what it is like.

Say to students:

- *Earth is actually one big system. The different spheres are smaller systems within the larger whole of the Earth. The parts of a system **interact**, or have an effect on each other.*

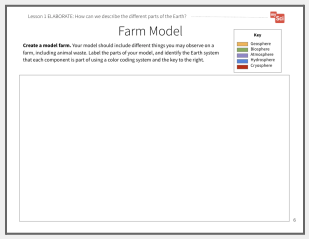
Next, ask students to use the model to explain why these interactions matter. Ask students:

- *How does one of the systems in your example affect the function of the other system?*

	▸ *What would happen if one of the systems was removed?* You can also show the following videos to help students see an example of how the hydrosphere and geosphere interact and how the hydrosphere affects the geosphere: What on Earth (3:42) and Weathering and Erosion (4:05) by Crash Course Kids.

ELABORATE

Students refine a model of a farm and illustrate the different Earth systems interactions on it.

 Farm Model Student Journal page	Show students the following videos of a farm: Dairy Farm (5:33) by ADAMideast and Immigrant Farmers Put Down New Roots (6:04) by Maryland Farm and Harvest. Have students identify where they observe interactions occurring between the things on the farm. Students may observe cows eating the grass. They may also make note of the farmer who discusses drinking the water, and breathing the air on the farm. After watching, say: ▸ *What could we add to our Farm Model to show the interactions of the different Earth systems?* ▸ *Let's develop a "Gotta Have It checklist" that tells the relationships we want to show on our model.*

What interactions should we include in our model?

- *Think of all the possible interactions we discussed in this lesson.* Students can refer back to the activity from the Explain phase.
- *What else should we include as part of our model so that other people know what we drew?*

As students come up with suggestions, add them to the "Gotta Have It Checklist." Examples of things the model's "gotta have" include:

- How the atmosphere interacts with the geosphere
- How the atmosphere interacts with the biosphere
- How the atmosphere interacts with the hydrosphere
- How the geosphere interacts with the biosphere
- How the geosphere interacts with the hydrosphere
- How the biosphere interacts with the hydrosphere
- A way of showing the interactions taking place (with a key or legend – for example, students may decide to use arrows to show waste particles moving into the geosphere or atmosphere)

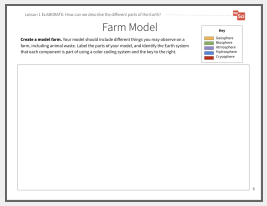
Have students add these interactions to their model (Farm Model Student Journal page).

Note: students are only expected to be assessed on two system interactions at a time. However, they may identify more than two interactions as part of their model. If students are struggling to make connections among systems, ask students:

- *Are there components you could add to your farm model that would help you identify interactions?*

EVALUATE

Students evaluate each other's farm models and give feedback.



Farm Model
Student Journal page

Formative Assessment

ESS2.A: Earth Materials and Systems Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. ~~The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather~~

Developing and Using Models Develop a model using an example to describe a scientific principle.

Have students share their models with a partner and give each other feedback. Did they have an example of the different sphere interactions? Did they label all parts of their model? How do their models compare with each other's?

Bring the class back together, and ask students to share out the differences and similarities in their models. This supports students to see the different ways you can represent and label things in models. Based on their discussion, students should change their models to reflect feedback.

Return to the class consensus model that was created in the Engage portion of lesson 1. Revise the class model to include the interactions the students described from their individual models.

Ask students what labels you should put on your drawing. This helps scaffold the revision process that students will engage with throughout this unit.

This activity is a chance to formatively assess students' understanding of the SEP Developing and Using Models, DCI ESS2.A, and the CCC System and System Models. Look for students to have met the criteria of the "Gotta Have It" checklist. See the student journal answer key for an example. If students are struggling to apply what they have learned in developing a model, use the class consensus model you created in the Engage of lesson 1 to support students to further develop their models.

To support student sensemaking across the unit, orient students back to the DQB. Ask students:

- *What did we observe during today's activity?*

Record the activity and their observations. Next, ask students:

- *What did we learn today?*

Record their responses. If students need a reminder, they can reference their student journals.

Ask students:

- *How might this help us figure out how farms are part of Earth's systems?*

To support students in making connections, ask:

- *What do we know about Earth systems?*
- *Are they isolated from one another? (*Students may say that the parts of the environment interact with one another. These interactions affect how different Earth systems function. Animals

System and System Models A system can be described in terms of its components and their interactions.	(biosphere) on farms drink water (hydrosphere). Plants (biosphere) grow in soil (geosphere).) Next, ask students: ▸ *What new questions do you have? (*They may have new questions, such as: Are all interactions between Earth systems beneficial? Can some interactions cause problems?) Do not provide these questions for students, instead help them start thinking about these ideas by focusing their attention to the interaction of different systems that they labeled on their models and how that could relate to the anchoring problem: We need farms to grow food, but the process of producing food for all of us can harm Earth systems. Have students place their questions into existing categories, or create new categories.

Section 2: Quick View

How does our use of natural resources on farms affect Earth's systems?

LESSON / LEARNING TARGET	VIDEO & TEXT RESOURCES	REMOTE LEARNING		KEY TAKEAWAY	VOCABULARY Quizlet Link Glossary Link
		INTERACTIVES & MINI LESSON VIDEOS	HANDS-ON AT HOME SUGGESTIONS		
Lesson 3: **What are natural resources, and how do humans use them?** Obtain information about what	EIA Energy Kids Welcome to the	What Are Natural Resources? Mini-Lesson	Have students walk around their home or neighborhood to record data about uses of natural resources.	Natural resources are Earth materials, such as air, water, soil, and energy that are used by humans to live.	fossil fuel natural resource non-renewable resource

natural resources are, how they form, and how they are used. Develop a model to show how natural resources are used as part of a farm system. *(3 days)*	Neighborhood				
Lesson 4: **How does our use of fossil fuels affect Earth's systems?** Obtain information about how the use of fossil fuels on a farm system affects the environment. Develop a model to show how fossil fuel use as part of a farm system affects the environment. *(3 days)*	What Causes Air Pollution Clean Air Outdoors Greenhouse Effect		Have students write a list of what types of fossil fuels they use in their home or that they see being used in their neighborhood. Describe how that might be affecting the air where you live.	The use of fossil fuels for energy causes pollution and can have negative impacts on human health, and Earth systems. Burning fossil fuels causes the Earth to heat up due to the greenhouse effect.	pollution
Lesson 5: **How does our use of water affect Earth's systems?** Analyze and graph data to explain the distribution of the salt and freshwater on Earth in terms of volume. Revise a model to explain how water use and waste production on farms interacts with Earth systems. *(3 days)*	Water cycle maps River Runner What is Eutrophication? The Ogallala Aquifer	How Is the Water on Earth Distributed? Mini-Lesson How Does Your Water Use Compare to the Rest of the World? Mini-Lesson	Have students track what they use water for, and how many minutes they use water per day.	The amount of freshwater available for human use is limited. Many activities, including farming, can cause water to become polluted, and deplete water resources. It is important for humans to conserve this natural resource.	aquifer freshwater saltwater
Lesson 6: **How can we use animal**	Biodigester		Have students collect kitchen scraps and watch them	Students figure out that animal waste	biodigester

waste as a natural resource? Plan and conduct an investigation to see how we can use animal waste as a natural resource on the farms. *(2 days)*	Timelapse		decompose either outside or in a cup covered with cellophane. What factors make them decompose faster or slower?	can create natural gas. We can use experimental design to consider how to opitimize the amount of gas produced from waste in a biodigester. This idea will be further investigated in Lesson 9, as a solution to energy use on farms.	Decomposer Constraint Criteria

Lesson 2: Summary

How do Earth's systems interact?

Time: 3 days

Learning Targets

Use models to explain the complex interactions between Earth systems .

Revise a model to show the interactions of Earth systems on a farm.

Summary

- In the last lesson, students identified the different systems of Earth and gave examples of each. They created an initial model of a farm that included the parts of the farm and the systems they are part of.
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- In the next lesson, students will learn about natural resources and how humans use them.

Building Towards

5-ESS2-1. (5.ESS2.A.1)

NGSS 3-Dimensions:

ESS2.A: Earth Materials and Systems

Developing and Using Models

System and System Models

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Literacy Connections	Remote Learning
Key Vocabulary **system**: a group of related parts that function together as a whole **interact:** have an effect on each other **Supplemental Reading Resources** Learn About Earth's Spheres	**Interactive & Mini Lesson Videos** How Does the Water Cycle Involve All of Earth's Systems? Mini-Lesson **Hands-on at Home Suggestions** Have students look for evidence of system interactions in their yard or neighborhood.

L2 – Five E Lesson Plan

ENGAGE

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Say to students:

Say to students:

- *We are trying to figure out how farms are part of Earth's systems in order to address the anchoring problem that producing food uses a lot of resources and that can harm Earth's systems. In the previous lesson, we described the different parts of a farm environment. We considered what Earth systems these things were part of.*

Have students name the Earth systems they worked on in the previous lesson (hydrosphere, geosphere, biosphere, and atmosphere). They can refer back to their models to help them remember the names of the systems. Write them on the board or chart paper.

Ask students:

- *How do you think the different Earth systems interact with each other?*
- *Can you give an example from something you have observed in your life?*

	Allow students to Turn and Talk, then share a few answers with the whole class.

EXPLORE

Students use a model to explain how systems interact on Earth.

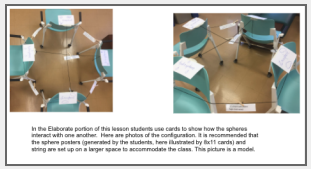
Teaching Tip:

Example of possible system interactions:

Fast flowing water erodes rocks (hydro/geo). The water is the cause, and erosion is the effect.

Water vapor creates clouds (atmo/hydro). Water vapor is part of the atmosphere, and when it condenses to form clouds, water drops are part of the hydrosphere.

Plants use carbon dioxide and give off oxygen. (bio/atmo). The plants are part of the biosphere, and the oxygen they give off is part of the atmosphere.



In the Elaborate portion of this lesson students use cards to show how the spheres interact with one another. Here are photos of the configuration. It is recommended that the sphere posters (generated by the students, here illustrated by 8x11 cards) and string are set up on a larger space to accommodate the class. This picture is a model.

Say to students:

- *Let's explore ways that the systems of the Earth interact with each other. We're going to look at examples of things that happen on our planet. Each group will decide which systems are interacting, and pin the card on the string that links the two systems. Then, we will look at what other groups decided and ask questions about why they made those choices.*

Label the walls, chairs or desks: Atmosphere, Biosphere, Hydrosphere, Geosphere using the index cards. Tape a string between each of the four walls, chairs, or desks at the site of the posters, so that each sphere is connected to every other sphere (it will look like a box with an x in it — six pieces of string).

Explain that each student or group will get cards that show spheres interacting, and they should clip it on the correct string with the clothespin you will give them. To facilitate student discussions about the cards, as you walk around you can ask:

- *What interactions do you see happening in your cards?*
- *How do you know those interactions are taking place?*
- *Which string do you think this card should go on? Why?*

If students are struggling, use the examples in the Teaching Tip to support them. Pass out Interaction Cards and clothespins to the students. Have the students use a clothespin to clip the interactions on the correct strings.

Tutorial	Here is a teacher tutorial for this activity. You can also do this activity virtually using the Earth Systems Interaction game.

EXPLAIN

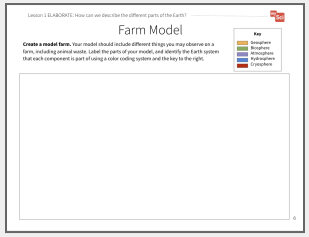
Students use a model to explain how water moves through and influences systems on Earth.

Teaching Tip: If you teach Unit 23 "Our Place in the Universe" first, this will be a review for your students. If they do not remember, you can remind them by giving them an example from Unit 23. One example could be our solar system, that is composed of the different parts including the planets, moons, and the sun.	Once students have placed their card, have each student or group share their card, explain which systems are interacting, and the evidence that supports why they think that. Give students time to ask questions and make alternative claims about which spheres are interacting. To support students to do this, consider using: Conversational Support for Sharing and Expanding on Each Other's Ideas from STEM Teaching Tools. Now is a good time to introduce or review* what a **system** is with students – a group of related parts that function together as a whole. You may ask them what they think a system is, and what it is like. Say to students: ▸ *Earth is actually one big system. The different spheres are smaller systems within the larger whole of the Earth. The parts of a system **interact**, or have an effect on each other.* Next, ask students to use the model to explain why these interactions matter. Ask students: ▸ *How does one of the systems in your example affect the function of the other system?* ▸ *What would happen if one of the systems was removed?* You can also show the following videos to help students see an example of how the hydrosphere and geosphere interact and how the hydrosphere affects the geosphere: What on Earth (3:42) and

	Weathering and Erosion (4:05) by Crash Course Kids.

ELABORATE

Students refine a model of a farm and illustrate the different Earth systems interactions on it.



Farm Model
Student Journal page

Show students the following videos of a farm:

Dairy Farm (5:33) by ADAMideast and

Immigrant Farmers Put Down New Roots (6:04) by Maryland Farm and Harvest.

Have students identify where they observe interactions occurring between the things on the farm. Students may observe cows eating the grass. They may also make note of the farmer who discusses drinking the water, and breathing the air on the farm.

After watching, say:

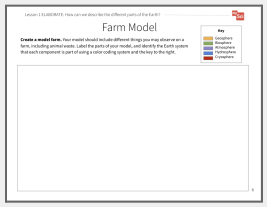
- *What could we add to our Farm Model to show the interactions of the different Earth systems?*
- *Let's develop a "Gotta Have It checklist" that tells the relationships we want to show on our model. What interactions should we include in our model?*
- *Think of all the possible interactions we discussed in this lesson.* Students can refer back to the activity from the Explain phase.
- *What else should we include as part of our model so that other people know what we drew?*

As students come up with suggestions, add them to the "Gotta Have It Checklist." Examples of things the

	model's "gotta have" include: - How the atmosphere interacts with the geosphere - How the atmosphere interacts with the biosphere - How the atmosphere interacts with the hydrosphere - How the geosphere interacts with the biosphere - How the geosphere interacts with the hydrosphere - How the biosphere interacts with the hydrosphere - A way of showing the interactions taking place (with a key or legend – for example, students may decide to use arrows to show waste particles moving into the geosphere or atmosphere) Have students add these interactions to their model (Farm Model Student Journal page). Note: students are only expected to be assessed on two system interactions at a time. However, they may identify more than two interactions as part of their model. If students are struggling to make connections among systems, ask students: ▸ *Are there components you could add to your farm model that would help you identify interactions?*

EVALUATE

Students evaluate each other's farm models and give feedback.

 Farm Model	Have students share their models with a partner and give each other feedback. Did they have an example of the different sphere interactions? Did they label all parts of their model? How do their models compare with each other's? Bring the class back together, and ask students to share out the differences and similarities in their models. This supports students to see the different ways you can represent and label things in models.

Student Journal page

Formative Assessment

ESS2.A: Earth Materials and Systems Earth's major systems are the geosphere (solid and molten rock, soil, and sediments), the hydrosphere (water and ice), the atmosphere (air), and the biosphere (living things, including humans). These systems interact in multiple ways to affect Earth's surface materials and processes. ~~The ocean supports a variety of ecosystems and organisms, shapes landforms, and influences climate. Winds and clouds in the atmosphere interact with the landforms to determine patterns of weather~~

Developing and Using Models
Develop a model using an example to describe a scientific principle.

System and System Models
A system can be described in terms of its components and their interactions.

Based on their discussion, students should change their models to reflect feedback.

Return to the class consensus model that was created in the Engage portion of lesson 1. Revise the class model to include the interactions the students described from their individual models.

Ask students what labels you should put on your drawing. This helps scaffold the revision process that students will engage with throughout this unit.

This activity is a chance to formatively assess students' understanding of the SEP Developing and Using Models, DCI ESS2.A, and the CCC System and System Models. Look for students to have met the criteria of the "Gotta Have It" checklist. See the student journal answer key for an example. If students are struggling to apply what they have learned in developing a model, use the class consensus model you created in the Engage of lesson 1 to support students to further develop their models.

To support student sensemaking across the unit, orient students back to the DQB. Ask students:

- *What did we observe during today's activity?*

Record the activity and their observations. Next, ask students:

- *What did we learn today?*

Record their responses. If students need a reminder, they can reference their student journals.

Ask students:

- *How might this help us figure out how farms are part of Earth's systems?*

To support students in making connections, ask:

- *What do we know about Earth systems?*
- *Are they isolated from one another? (*Students may say that the parts of the environment interact with one another. These interactions affect how different Earth systems function. Animals (biosphere) on farms drink water (hydrosphere). Plants (biosphere) grow in soil (geosphere).)

Next, ask students:

- *What new questions do you have? (*They may have new questions, such as: Are all interactions between Earth systems beneficial? Can some interactions cause problems?)

	Do not provide these questions for students, instead help them start thinking about these ideas by focusing their attention to the interaction of different systems that they labeled on their models and how that could relate to the anchoring problem: We need farms to grow food, but the process of producing food for all of us can harm Earth systems. Have students place their questions into existing categories, or create new categories.