Coherence and Alignment Among Science Curriculum, Instruction, and Assessment (CASCIA) Project

Grade 5 Unit 3: Earth Systems and the Solution of Water Problems

Interpretive Guidance and Instructional Strategies for Educators

May 2025

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Purpose

The purpose of this document is to help educators understand their students' performance on the Grade 5 Unit 3 Science Assessment and to provide instructional strategies and resources for planning and adjusting instruction to help students learn, whether it involves reteaching previously addressed concepts and skills from the prior instructional unit or planning additional learning opportunities or interventions in the subsequent unit.

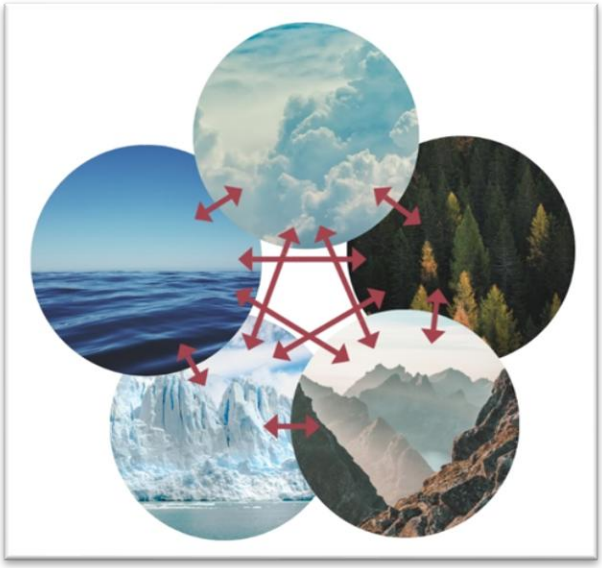

Image: Climate System
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Source: Own work
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Unit Overview

By engaging in this unit, students deepen their knowledge of the interconnectedness of Earth's systems, how different Earth systems interact with each other, and how water plays an important role for each system, especially the biosphere. With a focus on defining problems, finding solutions, and comparing multiple solutions using criteria and constraints, students engage in real-world problem-solving of human impacts on Earth's systems.

Instructions for Educators

1. Based on your analysis of student work from the assessment, in combination with additional assessment evidence gathered over the course of the instructional unit, consider themes or trends in your students' performance. Refer to your students' scores on the Classroom Roster Report to determine the degree to which students in your classroom require additional instructional support based on their instructional needs levels—red, yellow, or green—for each performance category.
2. For each performance category, use the provided interpretive guidance (i.e., *What These Results Mean*, *Next Instructional Steps*, and *Example Scored and Annotated Student Work* located in the Grade 5 Unit 3 EOU Assessment Scoring Guide) to understand what your students likely know and are able to do and to consider next instructional steps based on their instructional needs levels. Scored and annotated student work samples are provided for each performance category to demonstrate the evidence students might demonstrate in response to each prompt for each possible score point. The student responses represent the full range of score points possible for each prompt based on the scoring rubric.
3. For each performance category, use the *Instructional Strategies and Resources* organized by Universal Design for Learning (UDL) principle to support the design and delivery of accessible instruction and learning opportunities for all students based on their performance on the Grade 5 Unit 3 Assessment and their recommended instructional needs. These instructional recommendations can be selected and used to intentionally plan instruction and learning opportunities for students across the range of instructional needs levels (i.e., red, yellow, green).

Universal Design For Learning

The instructional strategies and resources provided in this document are organized by the Universal Design for Learning (UDL) principles. UDL is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn." (CAST, 2022). Taking time to reflect on prior instruction when planning for accessible, differentiated, and culturally responsive instruction for diverse learners and culturally diverse classrooms serves to identify ways to improve future instructional practices. The UDL Guidelines provide a framework for this reflection. The guidelines include three principles: Multiple Means of Engagement, Multiple Means of Representation, and Multiple Means of Action & Expression as ways to focus on variety and flexibility in instructional practices.

Multiple Means of Engagement	*The WHY of Learning* - provide options for recruiting student interest, sustaining effort, and promoting motivation.
Multiple Means of Representation	*The WHAT of Learning* - provide options for displaying information, including alternatives for auditory and visual information, use multi-media, clarify vocabulary and symbols, support comprehending text, and guide information processing and visualization.
Multiple Means of Action & Expression	*The HOW of Learning* – vary the methods for student responses and collection of evidence of their learning, optimize access to tools and technologies, use multiple tools for construction and composing responses, facilitate managing information and resources, and enhance student capacity for monitoring progress.

By examining instruction and instructional materials through the lens of each of these principles, we can identify and thus reduce or remove barriers to diverse learners to promote accessible and equitable teaching and learning opportunities. Application of UDL guidelines and principles allows all students to engage with and be provided with multiple means of representing instructional content and expressing what they know and can do, which is similarly the purpose of the use of accommodations for students receiving special education, students who have a 504 plan, and emerging Bilinguals.

Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources

Interpretive Guidance for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1, Prompt 1, Parts A-D (4 points); Task 1, Prompt 2, Parts A-C (7 points); Task 2, Prompt 3 (4 points)*		
Red (0-8 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (9-13 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (14-15 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • Make **little or no attempt to** utilize data to determine the effects of a given human activity on the environment. • **Partially** complete a mathematical model/graph **with multiple inaccuracies** to represent relationships among the amounts of freshwater in various reservoirs on Earth. • Use **no or limited** evidence or information to support a description of the importance of water conservation and human stewardship of Earth. • Use **no or limited** evidence or information to **inaccurately** describe the importance of freshwater springs.	**This student is likely able to:** • **Correctly** identify **and** utilize **some** data to determine the effects of a given human activity on the environment. • **Complete** a mathematical model/graph with **few inaccuracies** to represent relationships among the amounts of salt water **and** freshwater in various reservoirs on Earth. • **Accurately** identify relationships shown in a diagram **or** graph to describe the importance of water conservation and human stewardship of Earth. • Use **some relevant** evidence **effectively** to **partially** communicate information related to the importance of freshwater springs.	**This student is likely able to:** • **Correctly** identify **and completely** utilize data to determine the effects of a given human activity on the environment. • **Develop** a mathematical model/graph with **no inaccuracies** to represent relationships among the amounts of salt water **and** freshwater in various reservoirs on Earth. • **Accurately** interpret patterns or relationships shown in a diagram **and** graph to provide **clear and concise** answers about the importance of water conservation and human stewardship of Earth. • **Completely and effectively** combine **and** communicate information related to the importance of freshwater springs.

Interpretive Guidance for Performance Category 1:
Analyze Data to Describe the Availability of Needed Natural Resources

Task 1, Prompt 1, Parts A-D (4 points); Task 1, Prompt 2, Parts A-C (7 points); Task 2, Prompt 3 (4 points)

Red (0-8 score points earned)	Yellow (9-13 score points earned)	Green (14-15 score points earned)
➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Use provided natural resources data to identify correct statements from a list of statements written in simple, non-academic terms about the relationship between available resources and human activity on the environment. • Use provided data to identify a graph that accurately represents salt water or freshwater distribution in specific reservoirs on Earth. • Use provided data/evidence to select an accurate description of the importance of water conservation or human stewardship of Earth's water.	**Provide opportunities for the student to:** • Match provided natural resources data to statements, including grade-level academic terms about the relationship between available resources and human activity in the environment. • Use provided data related to various water resources to complete a graph that has been partially set up. • Interpret and summarize various sources of information and data (e.g., tables, graphs, written descriptions) related to the importance of water conservation and human stewardship of Earth.	**Provide opportunities for the student to:** • Identify relevant data and information from multiple sources and varied forms to identify a cause-and-effect relationship related to human activity on the environment. • Use provided or gathered data related to various water resources to develop a variety of mathematical models and/or graphs to represent relationships. • Identify patterns or relationships from multiple sources and varied forms of data/information to generate a conclusion that includes grade-level academic terms about the importance of water conservation and human stewardship of Earth.

Instructional Strategies and Resources for Performance Category 1:
Analyze Data to Describe the Availability of Needed Natural Resources

Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	*Engagement in Justice-Centered Phenomena* Engage students in investigations of locally relevant and personally meaningful environmental justice issues (e.g., water insecurity, water conservation) in their communities to foster student agency and activism. • Discuss water-related issues in students' community and environment. • Discuss implications of a drought in the community. *Culturally Responsive Instruction* Foster an inclusive learning environment that is culturally responsive, drawing from and respecting students' cultural resources, backgrounds, and personal experiences. Provide a range of ways for students to engage in cooperative learning (e.g., think-pair-share, jigsaw, round robin) with diverse groupings of students.	• STEM Teaching Tool – Practice Brief 87 – This brief provides strategies and resources for identifying local environmental justice phenomena for science and engineering investigations. [https://stemteachingtools.org/brief/87] • Stem Teaching Tool – Practice Brief 31 – This brief explores the strategy of self-documentation to invite aspects of students' cultural lives and communities to select phenomena and design learning opportunities that are engaging and inclusive of all students. [https://stemteachingtools.org/assets/landscapes/STEM-Teaching-Tool-31-Building-on-Student-Interest.pdf] • Culturally Responsive Assessment – Goals, Challenges and Implications – This pdf shows how to create equitable classrooms; teachers and schools must be culturally responsive to their students. [https://ies.ed.gov/ncee/rel/infographics/pdf/REL_PA_Culturally_Responsive_Assessment.pdf] • Learning by Inquiry – Scientific inquiry refers to a student-centered learning approach where students conduct investigations by asking questions, proposing solutions, and solving problems while gaining knowledge about the natural world. [https://www.learningbyinquiry.com/how-to-use-scientific-inquiry-in-the-elementary-classroom/]

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Data Analysis through Discourse* Provide varied opportunities (stations, small groups, partners, whole class) for students to engage in interactive discourse to collect, organize, analyze, and use data to investigate phenomena. Students build on each other's ideas to visually recognize and describe patterns in data, including relationships among variables being measured (e.g., as one variable increases, another variable decreases) and what the patterns could indicate about the data. Opportunities for scientific discourse should be situated in authentic, interest-driven science investigations.	• Reimagining Discourse in the Classroom – This article defines discourse as it relates to teaching and learning. [https://ila.onlinelibrary.wiley.com/doi/full/10.1002/trtr.2108] • Talk Science Primer – This chapter from Ambitious Science Teaching offers background information, strategies, examples, and prompts for fostering and managing rich science discourse in the classroom. [http://stemteachingtools.org/link/0614b] • PD Playlist: Promoting Student Science Talk in the Classroom – This compilation of ideas and resources is designed to help classroom teachers incorporate more science talk in their classrooms as students engage in discourse to make sense of phenomena and design solutions to problems. [https://stemteachingtools.org/pd/playlist-talk] • Checklist: Goals for Productive Discussions and Nine Talk Moves – This checklist offers nine strategies and verbal prompts for engaging students in effective science talk. [https://inquiryproject.terc.edu/assessment/Goals_and_Moves.cfm.html]
	*Promoting Engagement through Interactive, Collaborative Games* Use interactive games and collaborative formats to reinforce disciplinary core ideas about the availability of needed natural resources worldwide, especially water.	• Wordwall Interactive Games – This site offers quick interactive games to reinforce concepts and vocabulary. All grade levels are included, so scroll until you find an appropriate level. [https://wordwall.net/community?localeId=1033&query=energy%20and%20matter] • Classroom Review Games – These ten innovative and entertaining classroom review games are designed to improve

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		knowledge retention and engagement. [https://blog.classpoint.io/classroom-review-games/] • Aquation: The Freshwater Access Game – In this interactive, web-based game from the Smithsonian Science Education Center, students manage wealth and water carefully to solve the world's water crisis, reacting to global events to balance global water resources. This game is available as a website for desktop and laptop computers and requires an app download for tablets and Smartphones. [https://ssec.si.edu/aquation]
	*Develop Self-assessment and Reflection* For many learners, recognizing that they are progressing toward greater independence is highly motivating. Then again, one of the critical factors in learners losing motivation is their inability to recognize their progress. Provide a range of tools such as charts to collect and display data related to their behavior and activities that include different ways learners get feedback. These ranges of tools and activities support students' capacity to self-regulate their progress by providing multiple models and scaffolds of different self-reflection techniques so that they can identify and choose optimal ones.	• Strategies for Self-Reflection – This site will fill your teacher toolbox with prompts and strategies that promote reflection on both the content and the practice of science. [https://www.calacademy.org/educators/science-notebooks-for-reflection] • 4 Ways to Incorporate Reflection in Science Lessons – This article shows how students can make personal connections to scientific concepts when lessons include opportunities for introspection. [https://www.edutopia.org/article/student-reflection-science-lessons/] • 5 Activities That Promote Reflection in the Classroom – This article describes the metacognitive work of reflecting on science learning boosts engagement and encourages the development of critical thinking skills in students. [https://www.edutopia.org/article/reflection-learning-tool/]

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	***Activate and Supply Background Knowledge*** Activate relevant prior knowledge (e.g., using visual imagery, concept anchoring, or concept mastery routines) and supply background knowledge about the distribution and sources of freshwater and saltwater on Earth, the concepts of water abundance and scarcity, and the effects of human water consumption and potential solutions for water conservation.	• The Politics of Water – This article talks about how water is free of countries' borders; our planet's water goes where it wants. This seems obvious, but many of us don't give much thought to transporting this vital resource that makes life possible. Problems arise when we limit our focus to our immediate needs (time) and our local area (place) needs. [https://gpm.nasa.gov/education/sites/default/files/lesson_plan_files/The%20Politics%20of%20Water_0.pdf] • The Role of Water in Earth's Processes – In this video [5:27], Paul Andersen explains water's vital role in the processes on the Earth's surface. [http://www.bozemanscience.com/ngw-ess2c-the-role-of-water-in-earths-surface-processes] • Water Shortage: Activities to Understand Facts – This series of activities is designed to help students understand some of the global facts about water security in visual and statistical terms. The activities can be used to promote engagement and rich discourse among students about the topic of water scarcity. [https://asiasociety.org/files/lp-watersecurity-activities.pdf] • The Water Project – Water scarcity is often a concept that students have difficulty visualizing. In this lesson, students will go through three different stations for approximately five minutes each to experience the effects of water scarcity. [https://thewaterproject.org/resources/lesson-plans/water-water-anywhere?utm_campaign=PM2024&utm_source=google&utm_medium=cpc&utm_term=&gclid=CjwKCAiA75itBhA6EiwAkho9e-

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		ia1iLOOof8OzZMc1Mx77IA_MOoPJ0oz5IPPe4v5xmO_EhTlH8ovhoC66gQAvD_BwE] • Earth's Water: A Drop in Your Cup – Our planet's surface may be mostly water-covered, but how much can we use? In this lesson, students will see how water is distributed across different sources and how much can be used by humans. They will also brainstorm ways to decrease their usage of fresh water. [https://www.calacademy.org/educators/lesson-plans/earths-water-a-drop-in-your-cup] • There's No New Water – This activity helps to explain some important questions. How much water is available for humans to use? How much is stored in the atmosphere, frozen in glaciers and ice caps, or the oceans? [https://groundwater.org/wp-content/uploads/2022/10/Theres-No-New-Water.pdf]
	Maximize Opportunities for Cross-Curricular Learning Provide explicit and recurring cross-curricular learning opportunities for students to generalize and transfer their learning about natural resources and the use of graphs and tables to organize, interpret, and make sense of patterns in data. **Common Core State Standards Connections:** *ELA/Literacy -* **RI.5.7** Draw on information from multiple print or digital sources, demonstrating the ability to locate an	• Close Reading of Informational Science Text – This video shares strategies for engaging students in close readings of informational texts, which include opportunities for independent reading, teacher modeling, and collaborative discussion. [https://www.youtube.com/watch?v=o_7MY8khBag] • Close Reading Protocol – This protocol provides steps and strategies for engaging students in close readings of informational texts. [https://www.facinghistory.org/resource-library/close-reading-protocol] • A Long Walk to Water, by Linda S. Park (720 Lexile) - This novel, based on a true account, tells the story of Nya, a girl from a small

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	answer to a question quickly or to solve a problem efficiently. *(5-ESS2-2)* **W.5.8** Recall relevant information from experiences or gather relevant information from print and digital sources; summarize or paraphrase information in notes and finished work; and provide a list of sources. *(5-ESS2-2)* **SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *(5-ESS2-2)* *Mathematics -* **MP.2** Reason abstractly and quantitatively. (5-ESS2-2) **MP.4** Model with mathematics. (5-ESS2-2) ***Present Information in Different Modalities*** Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas to describe the availability of needed natural resources.	village who walks miles each day to fetch water for her family and Salva Dut, an 11-year old boy separated from his family by the civil war in Sudan. The novel presents cross-curricular opportunities to explore the issue of water scarcity and human access to natural resources. Various literary and informational texts related to this topic can be used to supplement and support students' learning. [https://resources.finalsite.net/images/v1657552496/notredameriversideorg/b5swqivtcrsr7zickddz/ALongWalktoWaterbyParkLindaSue.pdf] • One Well: The Story of Water Earth**,** by Rochelle Strauss (960 Lexile) (YouTube video) – This nonfiction text discusses the interconnectedness of water on Earth and explores challenges of uneven distribution, access to, demands on, and water pollution. In the accompanying lesson from the STEM Education Center at WPI, students generate a solution for decreasing water consumption or increasing its availability in areas with little access. [https://www.orange.k12.nj.us/cms/lib/NJ01000601/Centricity/Domain/2410/One Well.pdf] • CommonLit: Who Are the Water Protectors? – This grade 5 informational text explains the important work of a special group of indigenous people, known as the Water Protectors, to protect and defend waterways. This connects with the idea of human consumption and the availability of natural resources.

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://www.commonlit.org/en/texts/who-are-the-water-protectors] • Show Me the Water - This NASA video [2:27] illustrates the distribution of water on Earth using scale models and shows how people use accessible freshwater. Refer to the Distribution and Uses of Water – Teaching Tips for ideas about activating prior knowledge and engaging students in the video through graphing and discussion. [https://az.pbslearningmedia.org/resource/buac19-35-sci-ess-distributionusewater/distribution-and-uses-of-water/] • Where's the Water? – This video [4:12] helps explain where all the water in the world is located. [https://az.pbslearningmedia.org/resource/869cecfa-f7ea-49d5-a191-8077eb5497c5/wheres-the-water/] • Data Nuggets - Data Nuggets are free classroom activities co-designed by scientists and teachers to bring contemporary research and authentic data into the classroom. Data Nuggets feature a scientist's role model and the story of what inspired their research. [http://datanuggets.org/about-nuggets-2/content-and-graphing-levels/] • Ocean and Freshwater Data Sources – This compilation of classroom-ready and easily accessible data resources provided by the National Oceanic and Atmospheric Administration (NOAA) offers lesson plans that use NOAA data and interactive, easy-to-use digital data repositories that can be integrated into a unit or

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		course. [https://www.noaa.gov/education/resource-collections/data/ocean-freshwater]

	*Clarifying Academic Vocabulary through Engaging with Phenomena*
	Provide varied opportunities for students to learn and apply vocabulary in diverse situations and contexts. Vocabulary retention improves when academic terminology is layered on conceptual understanding. To maximize vocabulary building, support students in conceptual understanding and apply the academic terminology using the strategies outlined below.
	• Build understanding of domain-specific vocabulary using a multi-sensory approach or having students participate in simulations.
	• Make connections between vocabulary and real-life or future opportunities.
	  ○ Explain, describe, give real-world examples, or provide concrete representations of vocabulary words rather than formal definitions. Vocabulary.com (see Resources) provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students.
	  ○ Build a vocabulary word wall for students to add and reference during instruction and self-guided activities or tasks.
		• STEM Teaching Tools – Practice Brief 66 – This article explains how to support emerging multilingual learners as they develop language that interprets and explains phenomena. [https://stemteachingtools.org/brief/66]
		• Vocabulary.com – This site provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. [https://www.vocabulary.com/]
		• Text Project – Word Pictures – This site provides Word Pictures that are free for educators to use. Their site includes word pictures for core vocabulary and various content areas including science and social studies. [https://textproject.org/wp-content/uploads/cvwp/CVWP-Water-bundle.pdf]
		• The Science Penguin – This site provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary terms. [http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html]
		• Interactive Word Walls Enliven Vocab Learning – This article with teaching strategies to support students' use of a word wall to build understanding of key vocabulary. [https://www.middleweb.com/37209/interactive-word-walls-enliven-vocab-learning/]

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	○ Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge. • Read books or watch videos related to vocabulary words and concepts. • Sort words, photographs, or concrete representations into categories. Text Project (see Resources) provides free Word Pictures for educators to use. It includes word pictures for core vocabulary and various content areas, including science and social studies. • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge. • Define domain-specific vocabulary (e.g., predator) using domain-specific and common terms. • Embed visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.). • Have students create their own glossary of terms.	
	*Using Scaffolds and Supports to Analyze and Interpret Data* Provide scaffolds for analyzing and interpreting data using graphs and tables and summarizing and communicating conclusions based on observed patterns, trends, and relationships among variables.	• Analyzing and Interpreting Data Graphic Organizer – This graphic organizer by the Wonder of Science, available in English and Spanish and both Google Draw and PDF formats, takes students through a six-step process for analyzing and interpreting data. [https://thewonderofscience.com/graphics]

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	• Model and demonstrate close reading skills when explaining charts, graphs, and tables, as students typically need multiple readings to interpret information presented graphically. • Use interactive tables with students by designing a table for students to complete or finish. Tables can progress from simplistic to more complex, requiring increasing steps to complete as students gain proficiency with reading and using them in the classroom. • Provide partially completed organizers and concept maps to help students connect new information to prior knowledge. • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge.	○ English - Google Draw or PDF ○ Spanish - Google Draw or PDF • Instructional Strategies – Analyzing and Interpreting Data – This list of instructional strategies includes ideas and scaffolds for supporting students as they learn to interpret data presented in graphs and tables. [https://www.sciencepracticesleadership.com/uploads/1/6/8/7/1687518/analyzing_data_instructional_strategies.pdf] • Assessment Resource Banks – Tables and Graphs – This resource provides research findings, teacher tips, and strategies for helping students develop, interpret, and use graphs and tables. [https://arbs.nzcer.org.nz/tables-and-graphs] • Project Learning Tree – This resource describes eight techniques for differentiated instruction methods. Try these techniques to reach every type of learner. [https://www.plt.org/educator-tips/8-differentiated-instruction-techniques/]
	***Use of Computers and Digital Tools for Data Analysis*** Introduce computers and other digital tools to record, categorize, and represent data. Students can gain experience using computer programs to transform their data between various forms, thereby aiding in identifying patterns.	• Kids' Zone Create a Graph – This interactive website from the National Center for Education Statistics provides a tool and tutorial for creating different graphs and charts that students can use to organize and present data. Students can interact with the tool to create and customize their own graphs with their own data sets. [https://nces.ed.gov/nceskids/createagraph/Default.aspx]

Instructional Strategies and Resources for Performance Category 1: Analyze Data to Describe the Availability of Needed Natural Resources *Task 1 Prompt 1, Parts A-D (4 points); Task 1 Prompt 2, Parts A-C (7 points); Task 2 Prompt 3 (4 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	• Applying Learning in Multiple Contexts – The article with resources shares ideas on incorporating many options for students to express their learning. [https://www.edutopia.org/article/applying-learning-multiple-contexts/] • Teaching with Multiple Modalities – In this Strategy Guide, you'll see how one lesson utilizes tiered texts and multiple modalities to meet the learning style needs of students. [https://www.readwritethink.org/professional-development/strategy-guides/teaching-multiple-modalities] • 25 Examples Of Multimodal Learning To Use In Your Classroom Today – This article shares some simple ideas to get you to think about using multimodal learning in your classroom today. [https://teachermade.com/25-examples-of-multimodal-learning/] • 60 Developmental Elementary Science Writing Prompts – What are the best ways to ask kids to write about science in your science classroom? This resource looks at how 12 American scientists actually write about science and then suggests some writing and journal prompts based on the scientists' work. [https://mimshousebooks.com/blogs/books/prompts]

Performance Category 2: Design the Best Solution to a Problem Involving Human Impacts on Earth Systems

Interpretive Guidance for Performance Category 2: Design the Best Solution to a Problem Involving Human Impacts on Earth Systems *Task 1 Prompt 1, Part E (3 points); Task 1 Prompt 3, Parts A-C (7 points); Task 3 Prompt 3, Parts A-C (4 points); Task 3 Prompt 4 (2 points)*		
Red (0-7 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (8-13 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (14-16 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • Select or **partially** describe a design solution to a problem related to the impact of human activity on the environment supported with **limited or unrelated** evidence. • **Attempt** to create a solution that addresses **few or no** constraints to a problem involving human impacts on Earth systems. • Recognize and apply **some** of the criteria **or** constraints of the problem to **partially** explain **the** benefit of a solution. • **Attempt** to describe a method **or** data needed to test the functioning of a design solution with **limited connection** to relevant criteria or constraints of the problem.	**This student is likely able to:** • Evaluate **and** explain the relative usefulness of a design solution to limit the impact of human activity on the environment supported with **some relevant** evidence to **most** specified design parameters. • **Apply** information to create a solution that **appropriately** addresses **some** design constraints to a problem involving human impacts on the environment and **accurately** compare which solutions support a design problem **or** which do not. • **Apply** scientific ideas to solve design problems involving human impacts on the environment and explain why **some** criteria are chosen over others. • Describe an **appropriate** method for testing a design solution **and** the data needed to	**This student is likely able to:** • **Accurately** evaluate **and** articulate the relative usefulness of a design solution by **effectively** utilizing evidence **relevant** to **all** specified design parameters. • **Appropriately combine** and **synthesize** information to create a solution that **completely** and **accurately** addresses all design constraints to a problem involving human impacts on the environment and **accurately** determine which solutions support a design problem **and** which solutions do not. • **Apply** scientific ideas to solve design problems involving human impacts **and correctly** explain why some criteria are chosen over others in light of **relevant** constraints.

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	conclude the functioning of the design solution.	• Describe an **appropriate and systematic** method for testing the functioning of a proposed solution **and accurately** describe the expected patterns or trends in data that reflect a successful solution.

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Next Instructional Steps		
Provide opportunities for the student to: • Collaboratively match potential design solutions to meet provided design requirements. • Given a set of design requirements and a design solution, identify design requirements met or not met by the design solution. • Identify from a set of provided design solutions that match the criteria or constraints. • Collaboratively discuss the advantages or disadvantages of a provided design solution for given criteria and/or constraints to the problem. • From a given set of methods and/or data, collaboratively select a method or data to test appropriately the functioning of a design solution for given criteria and/or constraints to the problem.	**Provide opportunities for the student to:** • From a list of potential design solutions, identify the most effective design using provided data to justify the selection. • Discuss and compare provided solutions to a design problem, determine which design constraints and requirements are addressed in each, and then revise each solution as appropriate to include all design constraints and requirements. • Practice evaluating which design criteria are necessarily addressed (i.e., relevant vs. nonrelevant) in a solution and collaboratively construct an explanation of the solution that includes those criteria. • Collaboratively evaluate the effectiveness of provided methods for testing a solution against the desired outcome(s) to develop a description of the functioning of the	**Provide opportunities for the student to:** • Evaluate the strengths and limitations of a design solution across each design requirement. • Utilize relevant data and information from multiple sources and varied forms to develop multiple design solutions that address the given design constraints and requirements for a given design problem. • Design a procedure to determine the effectiveness of a design solution. Include types of data needed to evaluate and determine strengths and limitations of the design.

	design solution using a provided grade-level academic word bank.	

Instructional Strategies and Resources for Performance Category 2: Design the Best Solution to a Problem Involving Human Impacts on Earth Systems *Task 1 Prompt 1, Part E (3 points); Task 1 Prompt 3, Parts A-C (7 points); Task 3 Prompt 3, Parts A-C (4 points); Task 3 Prompt 4 (2 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	***Optimize Individual Choice and Autonomy*** Offer learners choices to develop self-determination and pride in accomplishment and increase the degree to which they feel connected to their learning. Engineering design/problem-solving provides many opportunities for student choice and autonomy.	• DASH Student Autonomy and Empowerment – This article describes how empowering students results in more student engagement and connectedness. Skills and example strategies are provided. [https://www.cdc.gov/healthyyouth/classroom-management/pdf/DASH_Student-Autonomy-and-Empowerment.pdf]
	***Engagement in Justice-Centered Phenomena*** Engage students in investigations of locally relevant and personally meaningful environmental justice issues (e.g., water insecurity, water conservation) in their communities to foster student agency and activism. • Discuss water-related issues in students' community and environment. • Discuss the implications of a drought in the community. ***Optimize Relevance, Value, and Authenticity*** Foster a culturally relevant and responsive community, drawing from and respecting students' cultural resources, backgrounds, and personal experiences to promote interest in engineering.	• STEM Teaching Tool – Practice Brief 87 – This brief provides strategies and resources for identifying local environmental justice phenomena for science and engineering investigations. [https://stemteachingtools.org/brief/87] • Stem Teaching Tool – Practice Brief 31 – This brief explores the strategy of self-documentation to invite aspects of students' cultural lives and communities to select phenomena and design learning opportunities that are engaging and inclusive of all students. [https://stemteachingtools.org/assets/landscapes/STEM-Teaching-Tool-31-Building-on-Student-Interest.pdf] • Engineering Your Future – This collection of short videos introduces students to STEM career possibilities before they reach high school age. This video collection is designed to inspire girls, students of color, and all students about engineering and other in-demand STEM careers, with real stories from young STEM professionals who look like them. The videos can be used to motivate students to take part in engineering design solutions in the classroom.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://nebraskapublicmedia.pbslearningmedia.org/collection/http.www.engineeringyourfuture.org/t/engineering-your-future-middle-school-edition/]
	*Foster Collaboration and Community* Construct communities of learners engaged in common interests or activities. In the 21st century, all learners must be able to communicate and collaborate effectively within a community of learners. An essential part of engineering design is the ability to work with a team. Options should be provided on how learners build and utilize these important skills.	• 10 Teambuilding Games That Promote Collaborative and Critical Thinking – This article provides team-building games that can promote cooperation and communication, help establish a positive classroom environment, and hone students' skills to get along with their peers and work well with others. This is not something that can be cultivated through rote memorization or with strategically placed posters. [https://www.teachthought.com/pedagogy/team-building-games/]
	*Minimize Threats and Distractions* Create an accepting and supportive classroom.	• STEM Teaching Tool – Practice Brief 36 – This article, called *Failing Forward: Managing Student Frustration During Engineering Design Projects*, offers insight and strategies to reframe "failure" in engineering design as positive. Given the iterative nature of engineering design, it is inevitable that students will need to work through multiple iterations to develop a quality design. [https://stemteachingtools.org/brief/36] • Iteration in the Engineering Design Process – This video [1:38] can be shown to students to illustrate how failure in the design process can be positive. [https://www.youtube.com/watch?v=Obyqku2vWc4]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***

	*Vocabulary*
	Provide varied opportunities for students to learn and apply vocabulary in diverse situations and contexts. Vocabulary retention improves when academic terminology is layered on conceptual understanding. To maximize vocabulary building, support students in conceptual understanding and apply the academic terminology using the strategies outlined below.
	• Build understanding of domain-specific vocabulary using a multi-sensory approach or having students participate in simulations.
	• Make connections between vocabulary and real-life or future opportunities.
	  ○ Explain, describe, give real-world examples, or provide concrete representations of vocabulary words rather than formal definitions. Vocabulary.com (see Resources) provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students.
	  ○ Build a vocabulary word wall for students to add and reference during instruction and self-guided activities or tasks.
	  ○ Have students restate the vocabulary word in their own words. Take this opportunity to help students connect new vocabulary, especially general vocabulary, to prior knowledge.
		• STEM Teaching Tools – Practice Brief 66 – This article relates to supporting emerging multilingual learners as they develop language that interprets and explains phenomena. [https://stemteachingtools.org/brief/66]
		• Vocabulary.com – This site provides explanations of words using real-world examples. Once signed in, an educator can create word lists for students. [https://www.vocabulary.com/]
		• Text Project – Word Pictures – This site provides Word Pictures that are free for educators to use. Their site includes word pictures for core vocabulary and various content areas, including science and social studies. This link will take you to the Word Pictures page, where you can select "Text Project Word Pictures," "Physical Science," and "Forces Around Us." [http://textproject.org/classroom-materials/textproject-word-pictures/]
		• The Science Penguin – This site provides ideas to teach science vocabulary. The vocabulary demonstration activity uses real objects to teach vocabulary terms. [http://thesciencepenguin.com/2013/12/science-solutions-vocabulary.html]
		• Interactive Word Walls Enliven Vocab Learning – This article presents teaching strategies to support students' use of a word wall to build an understanding of key vocabulary. [https://www.middleweb.com/37209/interactive-word-walls-enliven-vocab-learning/

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	• Read books or watch videos related to vocabulary words and concepts. • Sort words, photographs, or concrete representations into categories. Text Project (see Resources) provides free Word Pictures for educators to use. It includes word pictures for core vocabulary and various content areas, including science and social studies. • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge. • Define domain-specific vocabulary (e.g., predator) using domain-specific and common terms. • Embed visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.). • Have students create their own glossary of terms.	• Three Strategies for Teaching Academic Vocabulary – This article provides strategies for teaching academic vocabulary. Engineering design includes many 2 and 3-tier domain, or content-specific, vocabulary. [https://www.middleweb.com/42075/3-strategies-for-teaching-academic-vocabulary/]
	***Guide Information Processing and Visualization*** • Provide graduated scaffolds that support information processing strategies for designing solutions to problems involving human impacts on the environment through questions that support productive talk. • Give explicit prompts for each step in the design process.	• Engineering Design Talk Moves – This document from STEM Teaching Tool #36 includes cognitive and metacognitive questions to support students with design thinking. When it comes to engineering design, teachers need different questions and talk moves to guide students as they are processing information and collaborating to solve problems. [https://teachscience4all.org/2014/11/05/engineering-design-talk-moves/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• What is Design Thinking? – This blog from Edutopia provides a model for approaching design thinking. Each step of the 4C model is explicitly described for teachers. [https://www.edutopia.org/what-is-design-thinking-for-educators#:~:text=Design%20Thinking%20is%20an%20approach,classroom%2C%20school%2C%20and%20community.]
	***Maximize Transfer and Generalization*** Provide explicit, supported opportunities to generalize learning to new situations. Using analogies of familiar experiences can help students transfer their learning to new situations.	• The Engineering Design Process: Taco Party – This video [3:37] uses the analogy of making tacos to help students see how engineers set out to solve real-world problems. [https://www.youtube.com/watch?v=MAhpfFt_mWM&list=RDCMUCNVJhdLLn3zkudE5VbAf-wg&index=10] • Jessi Has a Problem and Jessi and Squeeks Build a Better Backscratcher – These student-friendly videos [5:06] and [4:30] can be used to help students generalize and transfer the engineering design solution to another situation. [https://www.youtube.com/watch?v=RM04n0-QtNo&t=3s] and [https://www.youtube.com/watch?v=zrAl6JQ3sb4]
	***Activate or Supply Prior Knowledge*** Anchor instruction by linking to and activating relevant prior knowledge regarding the engineering design process and/or human environmental impacts (e.g., using visual imagery, concept anchoring, or concept mastery routines). • **Curiosity**: Find ways to develop interest by finding a "hook" to get students curious. Provide clues and have students ask questions to determine the correct answer.	• Intentional Teaching Inspires Intentional Learning – This article provides strategies for teachers to help students develop deep knowledge by making connections and seeing patterns with their learning. There must be true understanding of the content for the students to apply their learning to other contexts, such as engineering design. An infographic is provided. [https://www.mcrel.org/intentional-teaching-inspires-intentional-learning/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	• **Connection**: Help students recall their background knowledge and show how it connects to their new knowledge. Give explicit cues that will help them activate their background knowledge. • **Coherence**: Show students the big picture and help them find the connections and patterns in the details. Display nonlinguistic representations to help students recall information.	• STEM Teaching Tools – Practice Brief 39 – This article addresses how students' everyday experiences can support science learning through engineering design. It provides a model for adapting engineering lessons to engage students in science learning inspired by their everyday objects and experiences. [https://stemteachingtools.org/brief/39] • Problem-Solving Skills For Kids – This article presents teaching tips and resources for developing problem-solving skills for kids. Most students have learned and practiced problem-solving throughout their school years. This would provide a way to highlight those previously learned skills to apply to new situations. [https://www.kodable.com/learn/problem-solving-skills-for-kids]
	***Highlight Patterns, Critical Features, Big Ideas, and Relationships*** Students' ability to differentiate what is most important from what is unimportant or relevant is key to building a facility in their understanding of concepts. This ability enables students to use their time more wisely and integrate important information to understand phenomena. An effective way to make information more accessible is to provide explicit cues or prompts that assist students in attending to those features that matter most while avoiding those that matter least.	• Make Synthesizing Easy with These Simple Strategies – This blog post presents three strategies for helping students identify key elements when synthesizing information from multiple texts. [https://teachingideas4u.com/blog/2017/10/make-synthesizing-easy-with-these] • Problem-Solving Skills For Kids – This article presents teaching tips and resources for developing problem-solving skills for kids. Most students have learned and practiced problem-solving throughout their school years. This would provide a way to highlight those previously learned skills to apply to new situations. [https://www.kodable.com/learn/problem-solving-skills-for-kids]

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	Teaching Strategies	***Resources***
	• Highlight or emphasize key elements in text, graphics, diagrams, and formulas when helping students to gather and synthesize information during the design process. • Highlight previously learned skills that can be used to solve unfamiliar problems related to human impacts on the environment. • Use outlines, graphic organizers, unit organizers, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships.	• Earth and Human Interaction System Model – This graphic organizer from Wonder of Science can provide a scaffold for students to gather and organize information when researching their design problems. The site also provides a completed example. [https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5e18a85b766381076cf9e2b3/1578674267643/5-ESS3-1+Earth+and+Human+Interaction+System+Model+%28Student+Version%29.pdf] • Soil Erosion, Types and Causes, Soil Erosion and Ways to Prevent It, Soil Erosion and Conservation – These videos [3:46], [8:37], and [6:55] can be used as the teacher helps students to gather and synthesize information about soil conservation, practice generating criteria and constraints, and/or practice how to evaluate solutions. [https://www.youtube.com/watch?v=qNTOq1uEObc] [https://www.youtube.com/watch?v=jYjJktQeUVA] [https://www.youtube.com/watch?v=Nwr_IAZHf1k] • Build Skills with Quick STEM Mini-Lessons – This Middle Web Blog describes how to use mini-lessons to reinforce skills for successfully solving STEM challenges, particularly criteria and constraints. [https://www.middleweb.com/41919/build-skills-with-quick-stem-mini-lessons/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Scaffolds for Communicating through Scientific Explanation* Provide scaffolds for explanatory writing and discussions to describe a phenomenon or support a design solution (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural for students.	• Argumentation Evidence Card Sort – This activity is to support students' critical thinking, productive argumentative talk, and ability to argue evidence while sorting it and to provide a platform that gets students actively involved in a way that promotes respect and safety. [http://energyteacher.org/wp content/uploads/2018/11/Argumentation.pdf] • Decision Matrix – This tool supports students as they critique and refine design solutions based on several requirements. [https://www.sciencebuddies.org/cdn/science-fair-projects/engineering-design-process/decision-matrix-worksheet.pdf] • Tug of War – This site provides a routine and videos applying a collaborative routine to help students understand, reason, and appreciate the complexity of situations by determining the strength of their positions, statements, and solutions ('tugs') and reorder the 'tugs' based on collaborative discussion to create an explanation for their chosen design solution that supports students moving from the Decision Matrix to an explanation for their chosen design solution. [https://thinkingpathwayz.weebly.com/tugofwar.html] • Constructing Explanations – This website supports students in their scientific explanations for their chosen design solution. [https://www.calacademy.org/educators/constructing-explanations#:~:text=This%20scaffold%20encourages%20students%20to,follow%2Dup%20experiments%20or%20research]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• STEM Teaching Tool – Practice Brief 63 – This brief explores how to integrate the argumentation from evidence practice into engineering design projects. [https://stemteachingtools.org/brief/63] • Sentence-Starts for Claims During Different Stages of the Engineering Design Process – This tool "describes the importance of student argumentation within engineering lessons" and includes sentence starters and examples to support student argumentation as they design solutions to problems. [http://stemteachingtools.org/link/6304b]
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their arguments and learning in class. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.).	• Infographic Maker – This site provides presentation software, 'Infographics', that can include a collection of imagery, data visualization (e.g., pie charts and bar graphs), and minimal text to provide an understandable overview of a topic and to summarize learning with charts, graphs, and diagrams. [https://venngage.com/blog/infographics-maker?utm_source=google&utm_medium=cpc&utm_campaign=&utm_content=&utm_term=infographic%20maker&match=e&campaignid=19558960020&adgroupid=143879091486&gad=1&gclid=Cj0KCQjw9fqnBhDSARIsAHlcQYSnvSGACgz1oEBmzQLMma1B3UbfY5Ieynj1ZD6Y7st4Cmtmf7rpiVcaAlEYEALw_wcB] • Interactive Whiteboard – This site provides a 'web whiteboard' to sketch, brainstorm, and share ideas for teachers and students to collaboratively model and demonstrate conceptual

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		understanding and to support revising thinking. [https://webwhiteboard.com/]

Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes

Interpretive Guidance for Performance Category 3: **Model Relationships to Communicate Information about Earth's Surface Materials and Processes** *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Red (0-10 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (11-17 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (18-21 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
What These Results Mean		
This student is likely able to: • **Accurately** identify the components of a **few** of Earth's major systems in a given scenario or event. • **Inaccurately** describe how two of Earth's systems interact in a given scenario or event (e.g., the effect of plants on the atmosphere). • Use a model to develop an **incomplete** explanation of how two of Earth's systems are involved in a given scenario or event • Identify the components of two systems contributing most to an event (e.g., the formation of a freshwater spring). • Present a **limited or inaccurate** description of how Earth's spheres interact in a scenario	**This student is likely able to:** • **Accurately** Identify **and** sort components of **some** of Earth's major systems in a given scenario or event. • **Accurately** describe the interactions among respective components of two combinations of Earth's systems in a given scenario or event. • Use a model to develop **incomplete but accurate** explanations of how two of Earth's systems are involved in a given scenario or event. • Identify interactions **and** components of the systems contributing most to an event (e.g., the formation of a freshwater spring). • **Accurately** describe interactions between components of Earth's spheres referencing	**This student is likely able to:** • **Accurately** Identify **and** sort components of **all** of Earth's major systems in a given scenario or event in a given scenario or event. • **Accurately** describe how **any two** of Earth's systems and their respective components interact in a given scenario or event. • **Develop and complete** a model showing how Earth's systems are involved in a given scenario or event. • **Correctly identify and describe** interactions **and** components of the systems contributing most to an event (e.g., the formation of a freshwater spring). • Include **convincing and valid** relationships among components of Earth's spheres to

Interpretive Guidance for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Red (0-10 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (11-17 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (18-21 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
related to erosion (e.g., the effect of water on the geosphere).	relevant relationships (e.g., cause and effect).	support a description of a scenario related to erosion (e.g., the effect of water on the geosphere).

Interpretive Guidance for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Red (0-10 score points earned) ➢ **Extensive** additional instruction and reteaching of these skills is recommended. ➢ The student needs significant opportunities to reinforce and apply these skills in future learning.	**Yellow (11-17 score points earned)** ➢ **Moderate** additional instruction on these skills is recommended. ➢ The student needs additional opportunities to strengthen these skills in future learning.	**Green (18-21 score points earned)** ➢ **Minimal to no** additional instruction on these skills is recommended. ➢ The student is ready to extend these skills in future learning.
Next Instructional Steps		
Provide opportunities for the student to: • Label and/or identify Earth's major systems. • Identify and/or sort components of Earth's major systems using pictures, written and verbal descriptions, and concrete objects. • Select an accurate or inaccurate description of how two Earth's systems interact. • Select an accurate and complete model of how two Earth's systems interact. • Collaboratively discuss provided descriptions of how Earth's systems interact and identify accurate or inaccurate statements.	**Provide opportunities for the student to:** • Match components to each of Earth's spheres in a given scenario or event. • Select two of Earth's spheres and collaboratively discuss multiple interactions among their components. • Complete a partial model to support an explanation. • For specific components of a given event, identify which of Earth's spheres interact and how. For each example, discuss and describe relevant relationships (e.g., how they are connected and related, cause and effect, changes within one sphere lead to changes in another sphere).	**Provide opportunities for the student to:** • Compare and refine models of a wide range of macro-phenomena related to various interactions among Earth's spheres. • With and without using models, compare and refine descriptions of relationships of Earth's spheres in varied scenarios (e.g., how a change in one sphere results in a change in another sphere(s)).

Instructional Strategies and Resources for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Foster Collaboration and Community When Modeling* All learners need to build their skills to communicate and collaborate effectively within a community of learners. When carefully structured, peer cooperation and mentoring opportunities can significantly increase the available support for increased engagement. By establishing structures and routines for students to use during conversation and interactions, students can practice how to work most effectively with each other. Students can build their ability to collaborate in a community by learning when and how to ask peers or their teacher for help. Opportunities to practice these skills can be provided when collaborating with peers to model relationships between Earth's materials and processes. Provide a range of ways for students to engage in collaborative learning experiences (e.g., think-pair-share, jigsaw, round robin) with diverse groupings of students.	• What is Interactive Modeling? – This article provides concrete guidance for effectively using interactive modeling to actively engage students in their learning and better understand what is expected of them when carrying out procedures or routines or when engaged in collaborative learning opportunities. For example, students can learn routines through interactive modeling (e.g., how to ask questions and how to teach peers) when working in collaborative groups to model relationships between Earth's materials and processes. [https://www.responsiveclassroom.org/what-interactive-modeling/] • Teaching Kids to Give and Receive Quality Peer Feedback – This article supports teachers in developing a classroom culture with kind, helpful, and specific peer feedback at the center, another important norm for building toward non-teacher-centric learning. [https://www.edutopia.org/article/teaching-kids-give-and-receive-quality-peer-feedback/] • How to Use Cooperative Learning – This practice brief provides a general instructional flow for classroom collaboration with low, medium, and high time commitment modifications. [https://serc.carleton.edu/sp/library/cooperative/howto.html] • Assessing by Group Work– This practice brief provides insight as to when to assess student learning using group work tasks and its

Instructional Strategies and Resources for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		benefits and challenges and provides implementation strategies. [https://www.teaching.unsw.edu.au/assessing-group-work] • The Earth's Spheres – This video [4:14] simply explains Earth's spheres. [https://www.youtube.com/watch?v=vFEMQbI6rg4] • Earth System Interactions: Background Information – This website provides a set of explanations of interactions between Earth's systems using infographics from NASA. [https://mynasadata.larc.nasa.gov/basic-page/earth-system-interactions-background-information] • SEEd POD 5th Grade Characteristics and Interactions of Earth's Systems – This lesson plan supports collaborative modeling about a phenomenon involving Earth's interacting spheres. Reference pages 23-29 for the relevant lesson. [https://www.uvu.edu/education/docs/seed/5th-seedpod-2022-logos.pdf]
	***Optimize Relevance, Value, and Authenticity of Scientific Modeling*** A meaningful way that teachers recruit students' interest is to highlight the utility and relevance of learning and to demonstrate that relevance through authentic, meaningful activities. This can be achieved by modeling phenomena related to the interactions of Earth's spheres to identify causal relationships based on students' observations and personal	• NGSS Modeling is Not an Art Project – This article from iExploreScience elevates the usefulness and impact of scientific modeling. The author highlights distinctions between robust scientific modeling and artistic representations of scientific phenomena. [https://iexplorescience.com/ngss-modeling-is-not-an-art-project/] • Modeling Level 2: Modeling Phenomenon – This mini-lesson includes a student tutorial with video [7:05] and thinking slides to guide students in developing and using models.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	experiences in their world and their cultural resources and backgrounds. • Do freshwater springs happen in the student's community/state? • Do natural disasters that cause erosion happen in the student's community/state? • How do the Earth systems change or alter the community's livelihood?	[https://docs.google.com/presentation/d/10cMVQ6ddgbP_oL9PBAwBIF2R5MY9FTMywnyJEvoUBGE/template/preview] • Using Models to Teach Science – This commentary by Byung-Yeol Park, Laura Rodriguez, and Todd Campbell provides insight into the value of scientific modeling in challenging misconceptions, revising thinking, and constructing explanations. [https://www.nsta.org/using-models-teach-science] • Misconceptions in Earth Science – Use this list of common misconceptions in Earth Science from NASA to provide useful feedback on student models of interacting Earth systems. [https://oceanmotion.org/html/teachers/misconceptions.htm] • River systems misconceptions – Use this list of common misconceptions about river systems to provide useful feedback on student models of river systems. [https://www.nestanet.org/misconceptions] • Native Ways of Knowing – This article explores Alaska native perspectives on Earth and climate and "traditional ways of knowing." Students can benefit from understanding both the traditional knowledge of Native peoples and ongoing scientific research. These two methods of observing nature and solving survival challenges can provide complementary perspectives. [https://az.pbslearningmedia.org/collection/ean/t/earth-as-a system/]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Develop Self-assessment and Reflection* For many learners, recognizing that they are progressing toward greater independence is highly motivating. Then again, one of the key factors in learners losing motivation is their inability to recognize their progress. Provide a range of tools such as charts to collect and display data related to their behavior and activities that include different ways learners get feedback. These ranges of tools and activities support students' capacity to self-regulate their progress by providing multiple models and scaffolds of different self-reflection techniques so that they can identify and choose optimal ones.	• Self-Assessment – This practice brief from Cornell University's School of Education explains the benefits and considerations needed for successful self-assessment. [https://teaching.cornell.edu/teaching-resources/assessment-evaluation/self-assessment] • 7 Ideas to Teach Weathering, Erosion, and Deposition – This webpage contains ideas and activities for teaching the subject. The video [0:22], "Explore Model in Stations," can be used as an opportunity for students to critique an erosion model. [https://thesciencepenguin.com/2016/02/erosion.html] • Interaction between Earth's Spheres – This unit is designed in collaboration with Campbell Union School District teachers. It highlights student self-assessment opportunities within a unit on Earth's interacting sphere systems. [https://raft.net/lessons/interactions-between-earths-spheres/] • Weathering and Erosion – This interactive quiz game has four ability levels. [https://www.eslgamesplus.com/weathering-and-erosion-science-game/] • Matching Game: Spheres of Earth – This game allows students to evaluate their understanding and use of terms related to each of Earth's spheres. [https://www.educaplay.com/learning-resources/4083852-spheres_of_earth.html]

Instructional Strategies and Resources for Performance Category 3:
Model Relationships to Communicate Information about Earth's Surface Materials and Processes

Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)

Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	***Highlight Patterns, Critical Features, Big Ideas, and Relationships*** Students' ability to differentiate what is most important from what is unimportant or relevant is key to building a facility in their understanding of concepts. This ability enables students to use their time more wisely and integrate important information to understand phenomena. An effective way to make information more accessible is to provide explicit cues or prompts that assist students in attending to those features that matter most while avoiding those that matter least. Emphasize key elements or features—what to attend to—in text, graphics, photographs, diagrams, and charts. Use outlines, graphic organizers, unit organizers, concept organizer routines, and concept mastery routines to emphasize key ideas and relationships. In addition, highlight previously learned skills that can be used to explain newly introduced phenomena or problems.	• Teaching with Problem Based Learning – This site explores an educational approach, Problem-based Learning (PBL), in which students will first be presented with a problem, which is ideally a real-world situation that students can relate to or may encounter in the future. Students will then share information and ideas, search for information/evidence, and propose solutions within their groups. [https://educators4sc.org/teaching-with-problem-based-learning-pbl/?utm_campaign=&utm_medium=ppc&utm_source=adwords&utm_term=problem%20solving%20learning&hsa_tgt=kwd-299958716050&hsa_mt=b&hsa_acc=2755491261&hsa_grp=135097105352&hsa_ver=3&hsa_src=g&hsa_cam=16577231404&hsa_net=adwords&hsa_kw=problem%20solving%20learning&hsa_ad=587897265082&gclid=Cj0KCQiAqsitBhDlARIsAGMR1RhlWdK6xm2owowyFJWJ8DN2NN1o4IBwhitF4EvDZnb8o515SePRb8QaAoIyEALw_wcB] • Activating Prior Knowledge – This newsletter provides strategies for activating prior knowledge. Prior knowledge is important as it is a foundational building block for new knowledge. [https://teaching.vt.edu/teachingresources/adjustinginstruction/priorknowledge.html]

Instructional Strategies and Resources for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Clarifying Academic Vocabulary Through Modeling* The different ways information can be presented (e.g., vocabulary words, numbers, icons) can be challenging for students to access, given varying backgrounds, experiences, and languages. To promote accessibility for all students, link the different ways information is presented with alternative representations (e.g., glossary, charts, graphics, objects). Have these resources available during learning experiences to promote access and independence. Give students practice using academic vocabulary in context by providing opportunities to use relevant words in authentic models related to the interactions of Earth's processes and materials.	• Earth System Interaction Models – This Earth system-specific graphic organizer from Wonder of Science can be used to support student progress toward academic vocabulary while developing explanatory models of related phenomena [https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5e18a81aaf81e00261c016a6/1578674202698/5-ESS2-1+Earth+System+Interactions+Model+%28Student+Version%29.pdf] • Earth System Interaction Models – This exemplar response of an Earth system interaction model shows how students might utilize academic vocabulary in modeling and explanation writing. [https://static1.squarespace.com/static/59c3bad759cc68f757a465a3/t/5e18a843af0cd6290217d3d3/1578674244566/5-ESS2-1+Earth+System+Interactions+Model+%28Teacher+Version%29.pdf] • Four Spheres Part 1 (Geo and Bio)– Use this video [4:00] to scaffold vocabulary understanding and usage related to Earth's spheres and their interactions. [https://www.youtube.com/watch?v=VMxjzWHbyFM]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	*Presenting Information in Different Modalities* Provide information using a variety of multimedia (e.g., videos, interactives, simulations), informational texts, and formats to teach and reinforce disciplinary core ideas related to a phenomenon demonstrating the Earth's systems.	• What is Multimodal Learning? 35 Strategies and Examples to Empower Your Teaching – This article defines multimodal learning and presents strategies for the different modalities. [https://www.prodigygame.com/main-en/blog/multimodal-learning/] • Teaching through Different Modalities – This video [7:15] describes three main learning modalities: visual, auditory, and kinesthetic. It also describes the importance of including multiple modalities in instructional activities and assessments. [https://youtu.be/vyY6-QGHL74?si=eGY341K_UIDNh_mB] • Multimodal Science Teaching and Learning – A series of articles that explains science teaching is multimodal. Science teachers use pictures, symbols, and physical models to present scientific ideas and other instructional materials, including textbooks with photos, text, and other modes of representation. [https://www.tandfonline.com/doi/full/10.1080/23735082.2020.1752043#:~:text=Science%20teaching%20is%20also%20multimodal,support%20students%20in%20making%20meaning.] • Precipitation Education – This website contains links to many interactives, videos, lesson plans, and images related to the hydrosphere. [https://gpm.nasa.gov/education/lesson-plans/connect-spheres-earth-systems-interactions]

Instructional Strategies and Resources for Performance Category 3: Model Relationships to Communicate Information about Earth's Surface Materials and Processes *Task 2 Prompt 1, Parts A-C (5 points); Task 2 Prompt 2 (4 points); Task 2 Prompt 4, Parts A-C (6 points); Task 3 Prompt 1, Parts A & B (4 points); Task 3 Prompt 2 (2 points)*		
Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		• What are Weathering and Erosion – This animated video [6:02] defines and describes weathering and erosion. [https://www.youtube.com/watch?v=3OtEImDg61E] • Erosion and Deposition by Wind – This lesson contains a brief informational text that students can read independently. [https://www.ck12.org/book/ck-12-fourth-grade-science/section/2.7/ • How Springs Are Made – This short video [:27] presents information on how freshwater springs are made. [https://www.youtube.com/watch?v=f_rc_VYEnDE]
	*Activate or Supply Prior Knowledge When Modeling* Anchor instruction by linking to and activating relevant prior knowledge regarding the engineering design process and/or human environmental impacts (e.g., using visual imagery, concept anchoring, or concept mastery routines). • **Curiosity**: Find ways to develop interest by finding a "hook" to get students curious. Provide clues and have students ask questions to determine the correct answer. • **Connection**: Help students recall their background knowledge and show how it connects to their new knowledge. Give explicit cues that will help them activate their background knowledge.	• Prior Knowledge in Science Lessons – This article provides strategies, links, and further reading that might be useful to explore and activate prior knowledge at the start of a lesson or topic. This is important not only for the DCI of the cycling of matter but also for background knowledge of the SEP of modeling. [https://thescienceteacher.co.uk/prior-knowledge/] • Modeling Earth's Systems – This unit focuses on the scientific concept that Earth systems are dynamic and interact. The natural world can sometimes seem like a complex array of independent issues and phenomena. Use this pdf (start at page 36) for helpful ways to access student knowledge. [https://www.coreknowledge.org/wp-content/uploads/2019/09/CKSci_G5EarthSystems_TG.pdf]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
	• **Coherence**: Show students the big picture and help them find the connections and patterns in the details. Display nonlinguistic representations to help students recall information.	• Freshwater Springs – This article discusses the importance of freshwater springs and how we can protect them. [https://ensia.com/features/freshwater-springs/]
	*Scaffolds for Communicating through Models* Provide scaffolds for developing models to provide evidence to explain a phenomenon or support a design solution (e.g., sentence frames, graphic organizers, norms for whole class discussion, roles for students during small group activities) to support communicating in science-specific ways that may seem unnatural for students.	• National Science Foundation – Tools for Ambitious Science Teaching – This site discusses tools to help students construct and revise evidence-based explanations and models. A variety of strategies are provided for students to use models to make their thinking visible. [https://ambitiousscienceteaching.org/tools-face-to-face/#Gottahave] • Explanatory Models: Support Science Learning, NGSS, and MBI – This blog illustrates the role of scientific modeling in scaffolding scientific communication and constructing scientific explanations. [https://www.teachingchannel.com/k12-hub/blog/explanatory-models/] • Connect the Spheres: Earth System Interactions – This set of lessons from NASA provides scaffolds for building explanations of interacting spheres through modeling. [https://gpm.nasa.gov/education/lesson-plans/connect-spheres-earth-systems-interactions]

Instructional Strategies and Resources for Performance Category 3:
Model Relationships to Communicate Information about Earth's Surface Materials and Processes

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Instructional Strategies and Resources

	Teaching Strategies	***Resources***
	*Expressing Learning in Multiple Modalities* Provide multiple, flexible options for students to communicate their developed models and show how their models are helpful. • Use technologies that facilitate student participation and communication, such as discussion boards, podcasts, or blogs. • Allow students to choose a multi-modal project they would like to complete to demonstrate their learning, such as a poster presentation, debate, short film, lab report, blog, infographic, drawing, poetry, writing and performing a song, creating a game, etc. • Provide a variety of ways in which students can "write" to respond to questions (e.g., traditional form of writing, with sentence starters, using pictures, etc.)	• STEM Teaching Tools – Multiple Means of Action and Expression – This article provides considerations for engaging students through multiple means of action and expression. [https://stemteachingtools.org/sp/multiple-means-of-action-and-expression] • Automata: Storytelling Devices – This resource illustrates the art of storytelling from Hmong and Maya perspectives. Students can demonstrate learning through story. [https://new.smm.org/educators/interactive-lessons/automata-storytelling] • Earth Systems Graphic Organizer: Student Activity – This graphic organizer helps students analyze the processes and components of Earth System phenomena. [https://mynasadata.larc.nasa.gov/basic-page/earth-systems-graphic-organizer-student-activity] • Spheres of Earth – This NASA activity provides a highly scaffolded modality for students to demonstrate learning. [https://ares.jsc.nasa.gov/engagement/activities/spheres-of-earth.cfm] • GLOBE Earth System Posters – This NASA resource provides ways for teachers to support their students in analyzing, representing, and presenting global data in scientific poster format. [https://mynasadata.larc.nasa.gov/lesson-plans/instructional-videos-globe-earth-system-poster-lesson-plan]

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://venngage.com/blog/infographics-maker?utm_source=google&utm_medium=cpc&utm_campaign=&utm_content=&utm_term=infographic%20maker&match=e&campaignid=19558960020&adgroupid=143879091486&gad=1&gclid=Cj0KCQjw9fqnBhDSARIsAHlcQYSnvSGACgz1oEBmzQLMma1B3UbfY5Ieynj1ZD6Y7st4Cmtmf7rpiVcaAlEYEALw_wcB]
	***Build Fluencies with Graduated Levels of Support for Practice and Performance*** Foster increased independence by providing supports and scaffolds (e.g., digital reading, writing software, student mentors, differentiated feedback) to develop students' ability to practice and demonstrate their learning when information is presented in a variety of ways and formats (e.g., visual, audio, text, mathematical). Consider providing different levels of support that can be gradually released to enable students to think about how Earth's systems interact while giving students a choice about how they perform—demonstrate their learning—because this allows them to synthesize their learning in meaningful ways. Teachers can use the "I do, we do, you do" model when teaching this topic.	• Sentence Starters vs. Sentence Frames – This YouTube video [6:34] for teachers describes the difference between sentence frames and starters with guidance on when to use them based on the goal of the writing/speaking task. [https://www.youtube.com/watch?app=desktop&v=6LI6V8jxbXc] • Starting Out with Sentence Stems in Science – This website provides tips for using sentence stems in the science classroom with examples. Printable free classroom poster for science. [https://thesciencepenguin.com/2015/05/starting-out-with-sentence-stems.html] • Gradual Release of Responsibility Creates Independent Learners – This article describes how a combination of instructional methods can be successful for student learning. While this article is not specific to scientific modeling, the combination of demonstration and collaboration, known as the gradual release of responsibility, can be incorporated into helping students construct a model showing the Earth's Surface Materials and Processes.

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Instructional Strategies and Resources		
	Teaching Strategies	***Resources***
		[https://www.thoughtco.com/gradual-release-of-responsibility-4153992] • The Science Series, Making Scientific Models – This video [8:06] features a teacher instructing students on constructing a scientific model. The video could be used with students as they begin constructing a model of the Earth's Surface. A link to a poster could be displayed throughout the year to give students a reference when developing models. [https://www.youtube.com/watch?v=MgVCIGPBb9M] • Differentiated Feedback – This article offers tips for providing differentiated feedback when formatively assessing, which can provide a tool for developing fluencies such as scientific modeling. [https://assessmarter.weebly.com/differentiated-feedback.html] • Teaching Kids to Give and Receive Quality Peer Feedback – This article from Edutopia supports teachers as they develop a classroom culture with kind, helpful, and specific peer feedback at the center, another important norm for building toward non-teacher-centric learning. [https://www.edutopia.org/article/teaching-kids-give-and-receive-quality-peer-feedback/]