

Lessons 12–17

Reducing Damage from Erosion

Prepare

In previous lessons, students developed an understanding of weathering and erosion. In Lessons 12–16, students apply that knowledge to solve a problem in an engineering challenge. Students are introduced to the engineering design process through the work of the Wright brothers by reading excerpts from the book *Who Were the Wright Brothers?* by James Buckley Jr. (2014). They then are tasked with developing a way to reduce damage related to erosion caused by different amounts of rainfall. Students use the engineering design process to develop solutions and test them under multiple conditions. Groups view their peers' designs and suggest improvements based on established criteria. The design process should take approximately three days but may vary as materials, redesign, and time allotted can affect the timeline for completion. Finally, in Lesson 17, students present their solutions to their peers.

Application of Concepts

Task

Engineering Challenge

Phenomenon Question

How can people reduce damage related to erosion?

Student Learning

Knowledge Statement

Designed solutions can reduce the impact of Earth's processes on humans.

Objective

- Lessons 12–17: Apply the engineering design process to design a structure to reduce damage related to erosion.

Texas Essential Knowledge and Skills Addressed

- 4.2A **Plan and implement descriptive investigations, including asking well defined questions, making inferences, and selecting and using appropriate equipment or technology to answer his/her questions.** (Addressed)
- 4.2C **Construct simple tables, charts, bar graphs, and maps using tools and current technology to organize, examine, and evaluate data.** (Introduced)
- 4.2D **Analyze data and interpret patterns to construct reasonable explanations from data that can be observed and measured.** (Addressed)
- 4.2F **Communicate valid oral and written results supported by data.** (Addressed)
- 4.7B **Observe and identify slow changes to Earth’s surface caused by weathering, erosion, and deposition from water, wind, and ice.** (Addressed)

English Language Proficiency Standards Addressed

- 2E Use visual, contextual, and linguistic support to enhance and confirm understanding of increasingly complex and elaborated spoken language.
- 4A Learn relationships between sounds and letters of the English language and decode (sound out) words using a combination of skills such as recognizing sound-letter relationships and identifying cognates, affixes, roots, and base words.
- 5F Write using a variety of grade-appropriate sentence lengths, patterns, and connecting words to combine phrases, clauses, and sentences in increasingly accurate ways as more English is acquired.

Materials

		Lesson 12	Lesson 13	Lesson 14	Lesson 15	Lesson 16	Lesson 17
Student	Science Logbook (Lesson 12 Activity Guide)	●	●	●	●	●	●
	Science Logbook (Lesson 13 Activity Guide)		●	●	●	●	●
	Engineering Challenge (1 per group); materials will vary but may include the following: 1 stream table from Lesson 8; 1 ball bearing catch from the Energy Module kit (or small plastic house); 1 9-ounce clear plastic cup with 1 hole; 1 9-ounce clear plastic cup with 2 holes; 1 9-ounce clear plastic cup with 3 holes; pebbles, rocks, grass, and bucket (or other plastic container) from Lesson 9; water; supplies students bring from home (e.g., plastic or paper plates; cardboard boxes; paper towel rolls; string; straws; plastic, polystyrene, or paper cups; wooden skewers; masking tape; craft sticks; building blocks; clay)		●	●	●	●	●
	Science Logbook (Lesson 16 Activity Guide)					●	●
Teacher	<i>Who Were the Wright Brothers?</i> by James Buckley Jr. (2014)	●					
	Engineering Design Process (Lesson 12 Resource A) (optional)	●	●				
	Blank Engineering Design Process Chart (Lesson 12 Resource B) (optional)	●					
	Engineering Challenge Scenario (Lesson 12 Resource C)	●	●				
	Anchor chart, anchor model		●				
Preparation	Prepare classroom materials for the engineering challenge and determine how students will retrieve materials. Either line up all materials by item on a counter for students to access when needed or gather each group’s set of materials beforehand.			●			

Lesson 12

Objective: Apply the engineering design process to design a structure to reduce damage related to erosion.

Launch 2 minutes

Ask students to review the Phenomenon Question for this lesson: **How can people reduce damage related to erosion?** 

Tell students that in the next lesson, they will design and develop their own solution to a problem. In this lesson, they will prepare for the engineering challenge by reading about the Wright brothers, two extraordinary engineers who are credited with inventing and flying the world's first successful airplane.

Learn 33 minutes

Read about the Wright Brothers 13 minutes

Set the purpose for the read aloud; students should listen for how the Wright brothers used the engineering design process, a series of thoughts and actions, to design an airplane.  When students hear an important thought or an action the brothers took to design an airplane, they should write it on a sticky note.

Agenda

Launch (2 minutes)

Learn (33 minutes)

- Read about the Wright Brothers (13 minutes)
- Discuss the Engineering Design Process (20 minutes)

Land (10 minutes)



English Language Development

The word *reduce* is used frequently throughout the lesson. Sharing the Spanish cognate *reducir* may be useful (4A).



Teacher Note

Students should layer their notes onto the engineering design process after the read aloud. However, if students are unfamiliar with the process, project Lesson 12 Resource A during the reading to help students frame their thinking (5F).



English Language Development

Understanding the phrase *engineering design process* is required for students to participate fully in the activity. Introduce this term explicitly. Sharing the Spanish cognate phrase for *engineering design process* (*proceso de diseño de ingeniería*) may be useful. Additionally, consider sharing simplified diagrams of the process that include additional scaffolds for English learners (4A).

Introduce the book *Who Were the Wright Brothers?* (Buckley 2014). Read aloud chapter 5, “That’s Happiness!” pages 42–47, and excerpts from chapter 6, “Off to Kitty Hawk,” on pages 48 and 54–61.  If possible, project the pages of the book so that all students can read along and view the pictures. Pause periodically for students to record notes on the brothers’ design process.

Discuss the Engineering Design Process 20 minutes

Have students locate the engineering design process visual in their Science Logbooks (Lesson 12 Activity Guide). A copy of it is available as Lesson 12 Resource A to project for students who may benefit.

Call students’ attention to the first stage of the process, *Ask*. Explain that engineers define the problem and identify criteria (i.e., what is needed, what are the requirements) and constraints (i.e., what is possible, what are the limitations) in the *Ask* stage. 

► What problems did the Wright brothers want to solve?

- *The brothers wanted to build a flying machine. First, they decided to build a glider. (Page 42)*
- *To build their plane, they had to solve three problems: build an engine to move the plane forward, make a wing that could lift the plane, and control how the plane moves in the air. (Page 43)*



Teacher Note

After reading aloud chapter 5, read the first page of chapter 6, “Off to Kitty Hawk,” page 48. Then skip to the second paragraph of page 54, which contains more information about the engineering design process. Read aloud, starting with “The Wrights stayed in Kitty Hawk for weeks at a time” and continuing to the end of chapter 6.



Differentiation

If students are still unfamiliar with the engineering design process, they may struggle to identify examples from the text. To help students better understand the process, model returning to the text to find evidence for a few stages. Share thinking aloud to demonstrate how students might arrive at a given example of evidence. For example, say, “I notice on page 42 that the brothers read books to help them imagine possible solutions to their aircraft problems. I will put this under *Imagine* because that is part of researching potential solutions” (2E).



English Language Development

The following line of questioning involves vocabulary such as *flight* and *glider*. English learners may benefit from additional scaffolding in the form of sentence frames. Consider displaying and labeling pictures of gliders for visual reference. Additionally, consider using sentence frames such as the ones below to scaffold this conversation.

- The Wright brothers wanted to solve the problem of _____.
- The problem was _____ and the Wright brothers tried to _____.
- To build a plane, the Wright brothers _____.

Invite students to share relevant evidence from their sticky notes and post their notes in the Ask portion of the blank engineering design process chart (Lesson 12 Resource B).  Sample responses are included on the graphic below. If needed, reread relevant sentences on pages 42–43 to help students recall details.

Next, explain that in the *Imagine* stage, engineers conduct research to learn more about the problem, brainstorm possible solutions, and select a solution to explore.

► How did the Wright brothers imagine possible solutions to their aircraft problems?

- *They read books about flying. (Page 42)*
- *They looked at other people's designs for gliders, engines, and wings. (Pages 42, 43, and 44)*
- *They thought about their experience steering bicycles. (Pages 44–45)*
- *When twisting a long cardboard box, Wilbur realized the glider wings should twist. (Pages 45–46)*

Invite students to share relevant evidence from their sticky notes and post their notes in the Imagine portion of the blank engineering design process chart. If needed, reread relevant sentences on pages 42–45. 



Teacher Note

Project the blank engineering design process chart (Lesson 12 Resource B) or recreate one on a whiteboard or chart paper and let students add their sticky notes for all to see and discuss.



Content Area Connection: English

As students discuss the Wright brothers' engineering process, ensure that they explain what happened and why, citing specific information from the text. Encourage students to consider why specific events occurred by asking follow-up questions such as this: Why did the Wright brothers study other engineers' designs for similar inventions?

Continue introducing the stages of the engineering design process and using the questions below to discuss the Wright brothers' experience in each stage. After each question, ask students to fill in the next portion of the blank engineering design process chart (Lesson 12 Resource B) with relevant sticky notes.

Explain that in the *Plan* stage, engineers begin to develop a detailed design plan (e.g., drawings, physical models) and gather the materials required.

► How did the Wright brothers plan their design?

- They made tiny wings out of steel. (Page 44)
- The illustration shows that they wrote notes and drew pictures. (Page 46)
- The gliders were made of wood, cloth, wires, and hooks. (Pages 54–55)

Explain that in the *Create* stage, engineers follow the plan to build a prototype and test the design. Explain to students that a prototype is a working model of a device to test the design before the final device is produced.

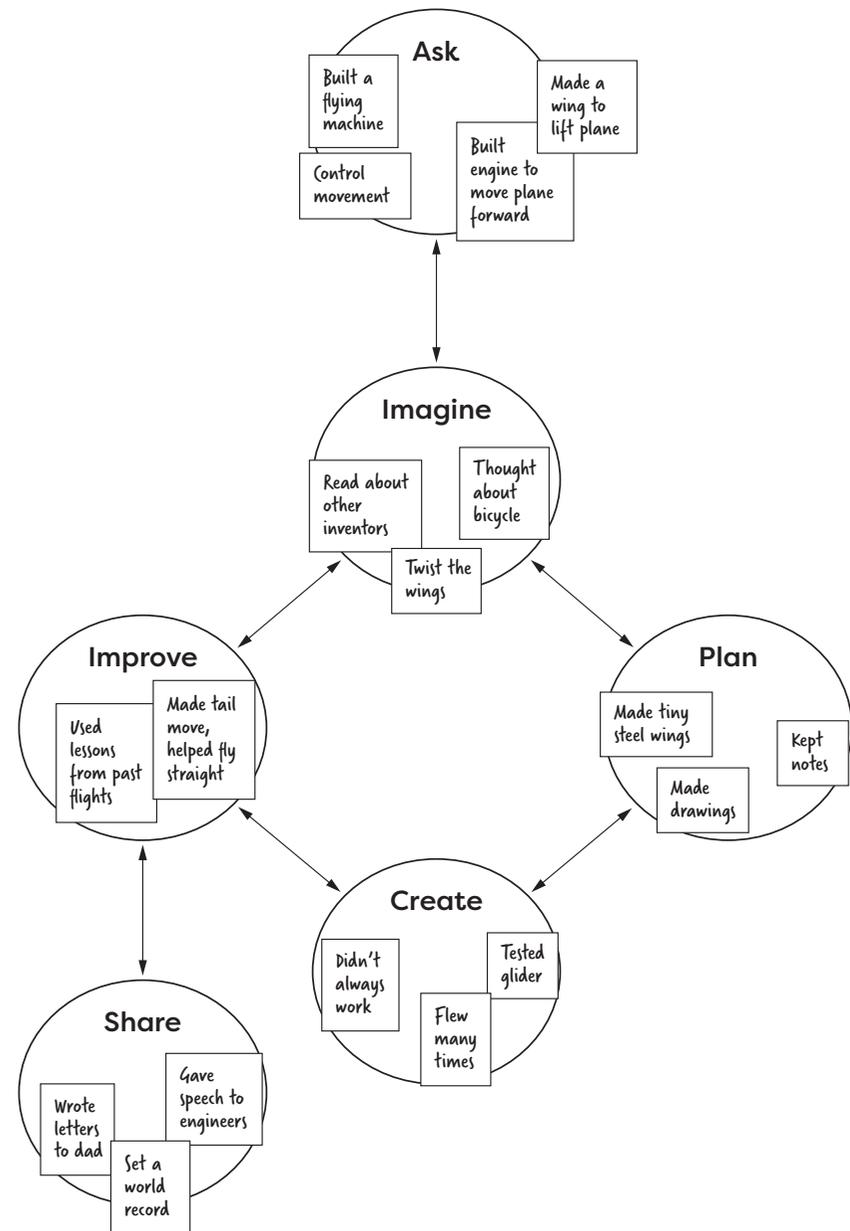
► How did the Wright brothers test their gliders?

- They tested the gliders a lot, and if a glider broke, they fixed it and tried again. (Page 54)
- The brothers took turns flying the gliders over the sand. (Page 56)
- Usually, the gliders just flew for a few seconds. But with each flight, the brothers learned more about flying. (Page 57)
- They tested the gliders in a place with steady wind. (Page 48)

Explain that in the *Improve* stage, engineers reevaluate the design and materials and determine how to improve the prototype.

► How did the Wright brothers improve their glider designs?

- They made better gliders with ideas they figured out in their test flights. (Page 58)
- One glider kept flying in circles. They made the tail move with the wings, which fixed the problem. (Page 59)



Explain that in the *Share* stage, engineers document and present ideas with others to receive feedback and support.

► **How did the Wright brothers share their ideas?**

- *They wrote letters to their father about their ideas. (Page 47)*
- *Wilbur spoke in front of engineers in Chicago. (Page 58)*
- *They set a world record for glider flights. (Page 60)*

After discussing the stages of the engineering design process, ask students to summarize the process for a partner by using examples from the Wright brothers' experiences.

Discuss that the engineering design process is more like a web than a circular or a linear process because it encourages engineers to move from one stage to any other stage in the process. While the simplified version (Lesson 12 Resource A) helps clarify thinking, students should always imagine that arrows are drawn to each step. 👤👤 Explain that engineering design is an iterative process that allows engineers to use what they learn in one stage to revise work completed in any other stage. For example, engineers often imagine, plan, create, and improve their designs many times before they share the design or prototype with colleagues.



Check for Understanding

As the class completes the blank engineering design process chart, use student responses to gauge understanding of the steps and nature of the process.

Evidence

Look for evidence that all students understand the steps and the questions or tasks that are associated with each step of the engineering design process in the context of the Wright brothers designing gliders.

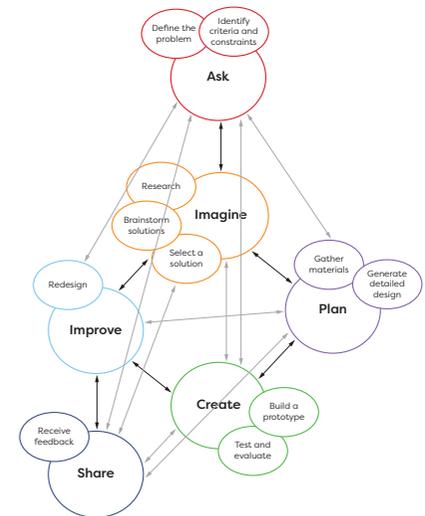
Next Steps

Students will gain additional experience with the engineering design process by participating in the engineering challenge. Support students as needed by referring to the engineering design process throughout the engineering challenge.



Differentiation

For students who would benefit from a visual aid, display the Engineering Design Process (Lesson 12 Resource A) and draw arrows from each step to the others (2E).



Land

10 minutes



Have students review what they learned about the Wright brothers in preparation for the engineering challenge and ask the following questions.

► **How did the Wright brothers use the engineering design process to solve a problem?**

- *They figured out what problems they needed to solve. Then they learned from other people.*
- *They tried hard and didn't give up. They tried a lot of designs before they found a good one.*

► **How did the Wright brothers work as a team?**

- *Wilbur thought of ideas and Orville was good at building them. (Page 46)*
- *They talked about their ideas with each other. (Page 59)*

While discussing student responses, emphasize the importance of planning, persistence, and teamwork. Encourage students to use those approaches in the engineering challenge during the next lesson.

To further prepare students for the engineering challenge, ask them what they know about landslides.  Briefly discuss recent landslides, either local or in other states. Discuss what might happen to a house when a landslide occurs.

Next, display an image that shows a house destroyed by a landslide caused by heavy rain (Lesson 12 Resource C, image only). Tell students that in upcoming lessons, they will use the engineering design process to develop and design solutions that reduce this type of damage.

► **Based on your understanding of erosion, what may have caused the landslide in this image?**

- *Maybe there was a lot of rainfall. When we had a lot of rainfall or water added to our stream table, a lot of the landscape shifted because of the water.*



Content Area Connection: Mathematics

Discuss how the web of problem solving in science is related to how humans solve most problems they encounter. Extend the engineering design process to problem-solving processes students use in math class, such as the Read-Draw-Write process (RDW).

First, students Read the word problem. Next, they Draw a picture to model the problem. This picture helps students identify a pathway for solving and which mathematical operation(s) to use. Finally, students solve and Write the answer as an equation and a written statement. Although RDW appears as a linear process, students often move between Read and Draw several times before moving to Write and move between Draw and Write several times.

Make connections between the Improve component of the engineering design process and problem solving in other areas of daily life.



English Language Development

Understanding the term *landslide* is required to participate fully in the engineering challenge. In addition to showing the image of a house destroyed by a landslide, consider showing more pictures and a video of landslides (2E).

► **Based on our investigations, how does rainfall affect the amount of erosion?**

- *The more rainfall we have, the higher the amount of erosion because there is more water.*

Work with students to develop a list of materials they will have access to while they work through the engineering design process. The list should include the stream table they created in Lesson 8, pebbles, rocks, grass, and an object to represent a house. 📄 Explain that students may also use materials from home (e.g., cardboard boxes, paper towel rolls, straws, masking tape, string, craft sticks, wooden skewers). Ask students to consider how they can use these materials to protect a house from damage.

To prepare for the Plan stage in the next lesson, ask students to begin looking for possible materials from home.



Teacher Note

If a ball bearing catch is not available, a small plastic house (or similar object) can be used.