THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Windbreak Challenge

How can I save the sand?

GRADE 2

Earth & Space

VAN ANDEL EDUCATION INSTITUTE

VAEI.ORG

INQUIRY-BASED SCIENCE

Earth & Space

Windbreak Challenge

Grade Level/Content	2/Earth and Space Science
Lesson Summary	*Windbreak Challenge* is the follow-up lesson to Save the Sand!. In this investigation, students use a pile of sand and simple objects to design and test a windbreak that prevents erosion.
Estimated Time	1, 45-minute class period
Materials	foil pan or plastic tray, sand, straws, ruler, various materials to be used as windbreak (twig, burlap, small rocks, plants, etc.), safety goggles, fan, Engineering Design Form, Assessment, journal
Secondary Resources	YouTube: Weathering and Erosion YouTube: Bill Nye Erosion You Tube: StudyJams Weathering and Erosion
NGSS Connection	**2-ESS2-1** Compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land. **K-2-ETS1-3** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.
Learning Objectives	• Students will design and test solutions to prevent wind erosion. • Students will evaluate each possible solution using the criteria and constraints of the problem.
Cross-Curricular Project Connections	Castles in the Sand, Trees Needed!

How can I save the sand?

Have you ever seen the Grand Canyon? If you go there, you can see high, rocky cliffs. The canyon is over 18 miles wide, and a mile deep. Far down at the bottom of the cliffs, flows the Colorado River. The river made the tall cliffs. Over millions of years, the water washed away bits of the rock. Each year it carved the canyon deeper. The river is not finished, though. The water still erodes rocks as it flows.

Water isn't the only thing that erodes the surface of Earth. Other forces are at work as well. What about a sand storm or a sand dune in the desert? These weren't caused by water. They were moved by wind. Wind can move sand to make giant sand dunes. Wind also wears away rocks to make amazing landforms. Ice is also a strong force. As water freezes, it gets bigger. It creates cracks in rocks and breaks them apart. In the lesson, Save the Sand!, students developed an understanding of the effect of wind on sand. In this investigation, students use a pile of sand and simple objects to design and test a windbreak that prevents erosion.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

- foil pan or plastic tray
- large plastic cup
- sand
- straws
- fan
- ruler
- various materials to be used as windbreak (twig, burlap, small rocks, plants, etc.)
- safety goggles
- Engineering Design Form
- Assessment
- journal

Part 2

INVESTIGATION FACILITATION

Before students begin the investigation, introduce the following scenario:

A sand dune is on the move and is coming closer and closer to burying your grandparents' farmhouse! Using the materials found around their yard and garage, build a windbreak to slow down the creeping dune.

Problem

Introduce the problem statement.

A windbreak is needed to prevent erosion of sand by wind.

- Post and go over the criteria and constraints for the problem:
  - Criteria for a successful windbreak:
    - ☐ It needs to prevent or slow wind erosion. *(i.e. should cause no more than a 1 inch height change in the sand dune with the windbreak)
  - Constraints students must build within:
    - ☐ They can only use materials that are provided.
    - ☐ They must continue building and testing designs to improve their design for the entire time given.

RICH LANGUAGE

If students are new to the engineering design process, review the concepts of **criteria** (*requirements for a successful design solution*) and **constraints** (*the limitations that must be taken into account when creating a possible solution, such as time, money, materials, scientific principles, etc.*) and how engineers use both throughout the design process.

* You negotiate with your students how to quantify this criteria

Personal Knowledge

Students capture what they already know about wind erosion.

- Have students review what they learned from the previous lesson, Save the Sand!.
- Generate a class list of what students already know about wind erosion.

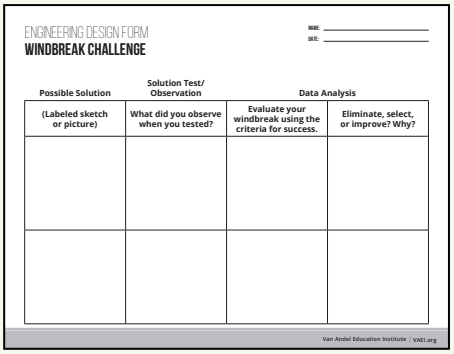
DISCOURSE

Conduct a collaborative *Think, Draw, Pair, Share*. Have them think about and draw what they learned about wind erosion. Then, have students share their drawing with a partner. Choose a few pairs to share their drawings with the class.

Possible Solutions

Students brainstorm design solutions to solve the problem within the criteria and constraints.

- Students use their knowledge to brainstorm ideas for possible solutions with a partner. Have each pair write in their journals:
  1. windbreak options
  2. different ways the windbreak can be built with available supplies
  3. ways to design the windbreak to slow or prevent erosion the best
- Students select ideas from each category above to use in their first design. Have them draw a sketch of their first possible solution on the Engineering Design Form.



ENGINEERING DESIGN FORM

WINDBREAK CHALLENGE

NAME: _____

DATE: _____

Possible Solution	Solution Test/ Observation	Data Analysis	
(Labeled sketch or picture)	What did you observe when you tested?	Evaluate your windbreak using the criteria for success.	Eliminate, select, or improve? Why?

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Engineering Design Form

CREATIVITY AND CRITICAL THINKING

Encourage students to "mess about" with the materials provided. Have them make observations to help them think creatively as they brainstorm. From that list, students will need to be critical thinkers as they select the ideas for their design solution.

Solution Test

Students build and test a possible solution within the criteria and constraints.

- Have students build and test their first possible solution.
- Have them use the same procedure they established in the Save the Sand! investigation to test the effectiveness of their solution. This will serve as their control to evaluate the effectiveness of their windbreak.
- If students have not completed *Save the Sand!*, refer to the Investigation Plan from that investigation as a guide.

INTEGRITY

- Encourage students to routinely evaluate if they are working within the constraints. Although it may be tempting, they are not to use any materials other than those provided.

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about their solution test. Help them understand that a good solution test must be repeatable, generate quality data, and minimize error. The more critically students think about their investigation plan, the more confident they will be in their results.

Observation

Students document their observations.

- Ask students to make observations of their solution test and record their findings on the **Engineering Design Form**. Have them make both qualitative (i.e. shape of sand dune) and quantitative (i.e. height of sand dune) observations on the effectiveness of their windbreak.
- Students may be tempted to begin refining or developing a new possible solution once they test their windbreak. Encourage them to continue through the observation and data analysis process to provide evidence that informs their new design.

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

- Have students **analyze** their data using the criteria for success:
  - It needs to prevent or slow wind erosion by_____.
- Have students **interpret** their results by indicating if the design needs to be eliminated, improved, or selected as a solution. If their design can be refined, have them summarize and record their ideas for improvement on the **Engineering Design Form.**
- Challenge students to design another possible solution and repeat the process (possible solution, solution test, observation, and data analysis) during the allotted time on the Engineering Design Form. You may have students take pictures of their subsequent designs as they refine and/or create new possible solutions. Even if the students find a solution, have them continue designing, building, and testing improved solutions for the entire time they are given.

CRITICAL THINKING AND SELF-DIRECTION

Engineering design is an iterative process where students use the data they collect on their design to improve, eliminate, or select their possible solution. Highlight for students that the process of continuous refinement within the boundaries of criteria and constraints is how engineers design solutions. As students refine or create a new possible solution, they need to be self-directed, critical thinkers throughout the engineering design process.

Secondary Knowledge

Students use secondary sources to understand erosion and how windbreaks are used to prevent and slow wind erosion.

YouTube: Weathering and Erosion

YouTube: Bill Nye Erosion

You Tube: StudyJams Weathering and Erosion

Soil Facts for Kids

- After reviewing these resources, students should have a good understanding of how weathering and erosion can affect land. They should also be aware of the need for engineering solutions to prevent wind erosion (*preventing sand dunes from burying homes, preventing farmers from losing their topsoil, etc.*).
- Students use this information in the reasoning portion of their solution.

Solution

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write a solution to the problem statement. Have them write their solution in their journal.
- Have students develop a **Claim** that solves the problem statement: A device is needed to prevent erosion of sand by wind.
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Windbreak Solution

Claim

We claim our 2nd design is the best solution that solves our problem. (See picture).

Evidence

We analyzed each windbreak design using the criteria. All of our designs helped prevent wind erosion. Our 2nd windbreak design did not have as much sand move. It only changed the height by ½ inch and it did not make as big of a hole in the sand.

Reasoning

Investigation: We are very confident in our evidence because we did a fair test by following our plan carefully. We analyzed each design and improved it each time.

Science: We learned from our Save the Sand! investigation and other readings and discussions that wind can be a force for erosion. If not stopped, wind can carry sand away from beaches, making the beaches smaller. Wind can also cause soil to move. This is a big problem for farmers. Fences and trees are used to help prevent wind erosion.

Evaluation

Students reflect on the investigation.

- Ask students what surprised them.
- Ask students how they used the criteria and constraints to guide their thinking.
- Ask students what problem they would like to solve next.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students use their knowledge in new contexts.

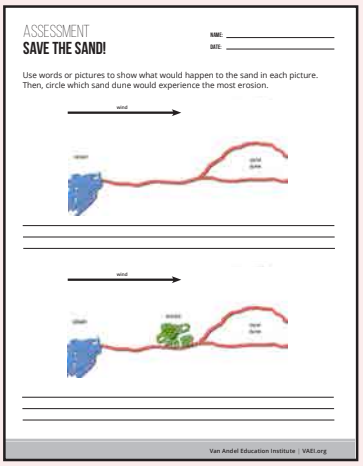
- Have teams share their solution (**claim**, **evidence**, and **reasoning**) with the class.
- Students can use their knowledge of wind erosion and windbreaks to design and test solutions to prevent other erosional forces such as water and waves.

Assessment

- Students present their solution (**claim**, **evidence**, and **reasoning**) that solves the problem statement within the given criteria and constraints.
- Give students the Beach Diagram and have them identify and explain which sand dune would experience the most wind erosion. (*The first*)

DISCOURSE

Have students conduct a Present and Defend to develop presentation skills as well as audience participation. Research teams present a summary of their investigation to the class. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Research teams defend their solution with evidence and reasoning.


ASSESSMENT
SAVE THE SAND!
NAME:
DATE:
Use words or pictures to show what would happen to the sand in each picture. Then, circle which sand dune would experience the most erosion.
wind
wind
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Assessment

Take This Lesson Across the Curriculum

Castles in the Sand

Building a sand castle can be fun. You just need a bucket and some sand. Some sand sculptures can be quite large and intricate. Imagine that there is going to be a sand sculpture contest, and your class is judging it! Students will design a sand sculpture contest.

Reading/Language Arts	Math	Science	Social Studies
Do We Have a Winner? Read *The Sand Castle Project* by Robert Munsch. Explain how the main character responds to the challenge in the story. What rules might you make for your sand sculpture contest? CCSS.ELA-LITERACY.RL.2.3	**Space for Sculptures** Sand sculptors need space for making their sculptures. Create a rectangle. Divide it into rows and columns that are the same size. Count to find the total number of squares. CCSS.MATH.CONTENT.2.GA.2	**Save the Sand!** Understand the problems of sand erosion to design a way to protect the sculptures during the competition. NGSS: 2-ES22-1	**Why Have Rules?** Imagine what it would be like if the sand sculpture contest had no rules. Write a paragraph explaining why rules are needed. NCSS: D2.Civ.3.K-2

Trees Needed!

Trees and shrubs are one solution to wind erosion. Farmers sometimes plant trees along the edges of their fields to prevent rich topsoil from being blown away. Some beach communities ask people to donate trees they no longer want to be used to build windbreaks. Students will propose a way to use trees to solve the problem of wind erosion at a beach.

Reading/Language Arts	Math	Science	Social Studies
Give Your Tree a Trip to the Beach! Students will write a letter to the editor to encourage community members to donate dead trees to be used as windbreaks at a local beach. The letter should provide reasons why this will benefit their community. CCSS.ELA-LITERACY.W.2.1	**How Many?** Estimate the length in feet of a shrub or a bush. Use a yardstick to check your measurements. Imagine that you want to protect a sand dune that is 10 feet wide. Estimate how many of these shrubs you would need. CCSS.MATH.CONTENT.2.MDA.3	**Save the Sand!** The trees are to help prevent sand erosion. Let's learn more about how a windbreak can help prevent this problem. NGSS: 2-ES22-1	**Who's in Charge?** Beach erosion is a serious concern in beach communities. Investigate which person or organization in a beach community is in charge of making sure beach erosion is avoided. NCSS: D2.Civ.6.K-2

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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ENGINEERING DESIGN FORM
WINDBREAK CHALLENGE

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