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Grade 3-5 STEM Challenge

The Power of Wind

Inspired by Gabi, an Electrical Engineer in the Indiana Uplands.

Published by Regional Opportunity Initiatives

GRADE 3-5 STEM CHALLENGE

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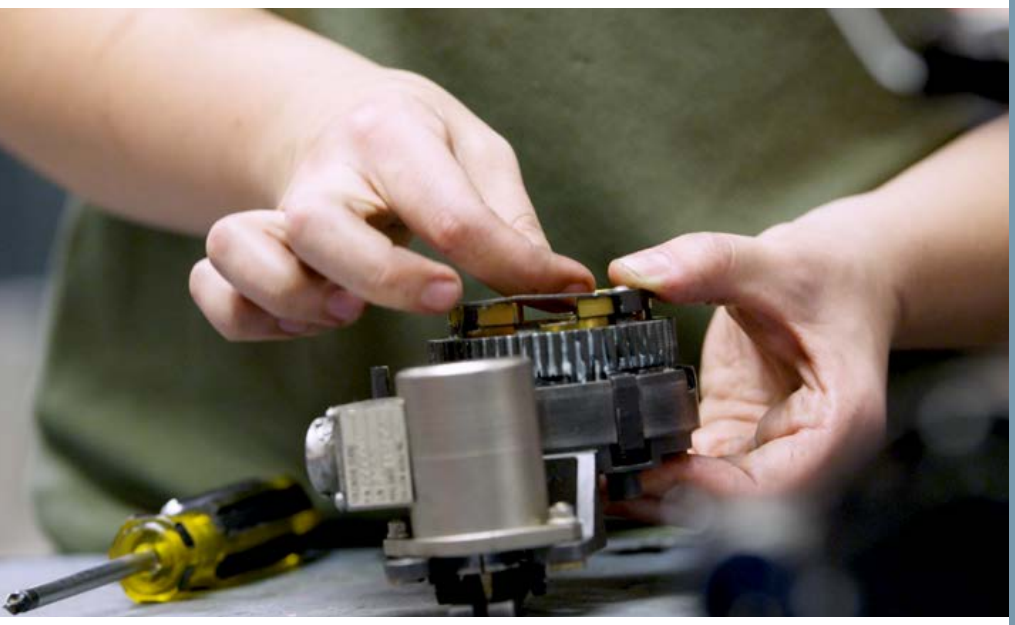
Inspired by Gabi, an Electrical Engineer in the Indiana Uplands.

Students will design and build a working windmill.



CAREER CONNECTION AND LESSON OVERVIEW

Gabi is an electrical engineer at NSWC Crane in southern Indiana. She a specialized engineer who deploys overseas with soldiers and designs solutions to problems they encounter while on the job. What Gabi likes most about engineering is that she gets to come up with creative solutions to real problems and, at Crane, those solutions help keep soldiers safe. When presented with a problem, engineers engage in a process that involves understanding the problem, brainstorming solutions, creating a preliminary design, testing, and redesigning.

In this activity, students will design a device that will use the power of moving air to raise a small figure from the table to the top of a tower. They will learn about how windmills gather energy from the wind and use that energy to do work. Students will use the engineering design process to create and refine their windmill designs.

LESSON TIMELINE

DAY 1 60 Minutes
- Show the inspiration video, "Gabi - Electrical Engineer"
- Read "Catch The Breeze"
- Plan windmill design

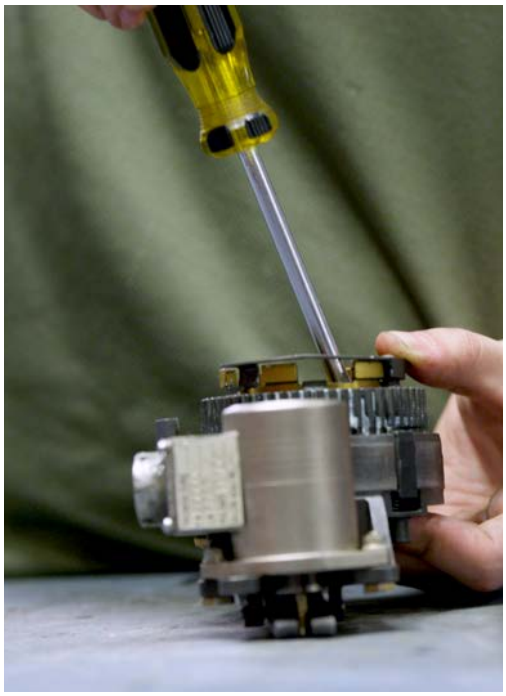
DAY 2 60 Minutes
- Create windmill design
- Test prototype
- Improve windmill design

DAY 3 60 Minutes
- Share windmill designs
- Communicate sucesses and challenges

Recommended Supplies

For the class:
- Milk carton, box, or scrap cardboard
- Skewers
- Corks
- String
- Small paper cups
- Construction paper
- Tape
- Scissors
- Ruler
- Additional assorted supplies
- Small figure (example: Lego "mini-fig"), (for optional extension)

Possible "wind" sources, including:
- manual fan
- electrical fan
- hairdryer



IN THIS CHALLENGE, STUDENTS WILL:

- Read “Catch the Breeze” to build background knowledge about wind energy.
- Design and build a windmill that will capture energy and turn when the “wind” blows on it.
- Document their engineering Design Process and share their prototypes and finished designs.

Standards

Science & Engineering Process Standards

SEPS.1 Posing Questions (for science) and defining problems (for engineering)

SEPS.2 Developing and using models and tools

SEPS.6 Constructing explanations (for science) and designing solutions (for engineering)

SEPS.8 Obtaining, evaluating, and communicating information

Engineering Standards

3-5.E.1 Identify a simple problem with the design of an object that reflects a need or a want. Include criteria for success and constraints on materials, time, or cost.

3-5.E.3 Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Computer Science Standards

3-5.PA.1 Use technology resources for problem solving and self directed learning, general-purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, facilitate learning, and individual/collaborative writing, communication and publishing materials.

3-5.NC.2 Use productivity technology tools for individual and collaborative writing, communication and publishing activities.

English/Language Arts

3.SL.3.1 Retell, paraphrase, and explain the main ideas and supporting details of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

4.SL.3.1 Summarize major ideas and supportive evidence from text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

5.SL.3.1 Orally summarize or respond to a written text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally.

Science Standards

3.PS.2 Identify types of simple machines and their uses. Investigate and build simple machines to understand how they are used.

4.PS.4 Describe and investigate different ways in which energy can be generated and/or converted from one form of energy to another form of energy.

4.ESS.2 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses effect the environment.

4.ESS.4 Develop solutions that could be implemented to reduce the impact of humans on the natural environment and the natural environment on humans.

5.E.SS.3 Investigate ways individual communities within the United States protect the Earth’s resources and environment.

Planning and Implementation

THE POWER OF WIND

Essential Vocabulary

- ENGINEER: a person who invents, designs, analyzes, builds, and tests objects and systems to make improvements or solve problems.
- ENGINEERING DESIGN PROCESS: A series of steps that a student or engineer follows to come up with an optimal solution to a problem
- ELECTRICAL ENERGY: Energy derived from moving electrons.
- MECHANICAL ENERGY: The total energy of an object, including it's moving energy (kinetic energy) and its stored energy (potential energy).
- PROTOTYPE: a first model of something from which other models are developed or copied.

In this challenge, students will:

- Listen to or read "Catch the Breeze" to build background knowledge about wind energy.
- Using the Engineering Design Process, create a prototype windmill that will capture energy from moving air.
- Share their prototype by documenting their process and communicating how they arrived at their finished windmill.

Before Class:

- Read the lesson plan to become familiar with the activity.
- Gather necessary materials. Be sure that you have enough materials and space for students to build and test their windmills in small groups.

Day 1

Introduction (30 Minutes)

Show students Gabi's career shadow video, located at https://regionalopportunityinc.org/gabi/.

Share with students William Kamkwamba's story using one of the following short videos:

- William's Story: The Boy Who Harnessed the Wind (Netflix trailer, 2:10)
- Moving Windmills: The William Kamkwamba Story (6:07)

Have students read the article Catch the Breeze for a brief introduction on how wind energy is gathered and used. After reading the article, have students write down a few key facts that summarize what they read and how it relates to William Kamkwamba's story.

Tell students that they will be working in small groups to create a windmill that will capture energy from moving air supplied by a hair dryer, fan, etc. and use it to do work.

Explain that William's windmill collected kinetic energy from the wind and converted it to electrical energy to help power his village. The students' first challenge will be to make a windmill that turns when blown on by a hair dryer or other air source. Once they have a design that accomplishes this task they can then refine their design to do something useful.

Optional Extension
If time allows, students can also extend this project to create a way to use this energy to raise a Lego figure to the top of the windmill tower. The energy created by the students' windmills will convert the wind's energy into mechanical power through a design that will be able to lift an object from the surface to the top of the tower.

Group students (3-4 students per group) and assign the following roles:

- The Building Lead will make sure that every group member's ideas are heard and that each group member contributes to constructing the conveyor. The building lead will also handle the conveyor when it is time to test the prototype.
- The Materials Manager will gather and organize materials the group has chosen for construction. The materials manager will observe during prototype testing.
- The Recorder will make sure that the group's ideas are recorded during the IMAGINE stage and will observe and record details of what takes place during prototype testing. These observations will help the group when making improvements.

Ask, Imagine, Plan (30 minutes)

As a class, discuss the challenge.

"How does the wind make the arms of a windmill turn? How can we design and build our own windmill that will turn in the breeze?"

Have the students write the questions in the ASK box on their Engineering Design Process sheet.

Introduce the building materials that will be available to the students. A suggested materials list is included on page 1 of this lesson plan. Allow students time individually to sketch a few designs of their windmill in the IMAGINE box on their Engineering Design Process sheet.

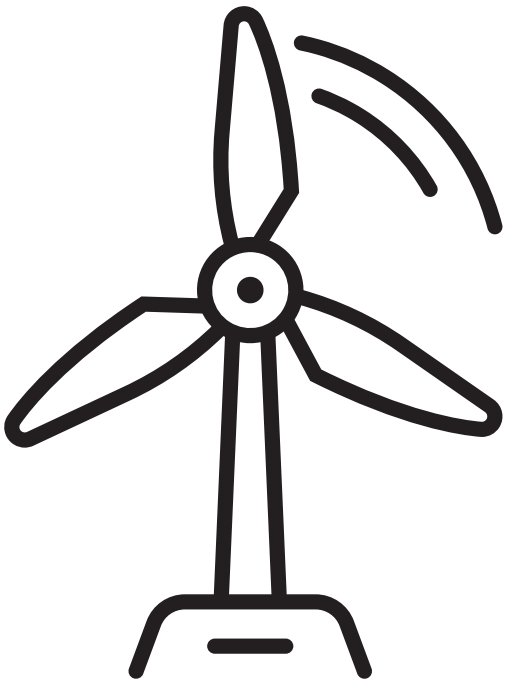
Once they have had time to IMAGINE individually, group students into teams. They will combine their individual ideas to create a plan. Record in this in the PLAN section of their Engineering Design Process handout.

Day 2

Create and Improve (60 Minutes)

Reframe the day and remind students what they accomplished the last time they worked together. Using their plans from Day 1, small groups will build their windmills.

Remind students that as each group completes their windmill design they should be testing their prototype and looking for ways to improve it. Students should continue the TEST/IMPROVE cycle until they have a model that spins when blown on by a hair dryer, fan, etc..



As students work, prompt them to brainstorm solutions to any issues they may run into. For example,

- What might happen if a strong gust of wind hits their windmill?
- How would different types of paper and different shapes and lengths for the windmill blades affect the outcome?

Students may also want to research by looking at pictures of windmills to get inspiration for this step. Students will reflect on the improvement process by completing the CREATE and IMPROVE sections of their Engineering Design Process sheet.

Day 3

Communicate (60 Minutes)

Students will work in their small groups or individually to complete the COMMUNICATE section of their data sheet. Have students use available technology (or another mode of presentation) to summarize their STEM Challenge. Presentations should include:

- a summary of what students learned about wind and energy.
- a summary of the information in the CREATE, IMPROVE, and COMMUNICATE boxes.

Extend the Challenge

Once students have a working windmill prototype, encourage them to discuss how they can use the energy their design captures and use it to do something useful. Challenge them to think about what they could add to their windmill that would allow it to raise a Lego figure from the table to the top of their windmill.

Ask students:

- *Would a simple machine help here? Our windmill is kind of like a wheel and axle. What could we use that would pull our Lego friend up?*
- *What materials do you have that could help? What materials or toolswould you like to have?*

Encourage students to expand and revise their windmill designs using the engineering design process to solve this challenge. Students may need to disassemble parts of their windmills apart and make adjustments to be able to create a lift system for their Lego person.

Career Exploration and Extension

Prompt students to think about and research what a career as an electrical engineer might involve.

- What does an electrical engineer do all day? What does Gabi do?
- Are all engineers the same? Do they do the same things?
- What kind of education would a student need to become an electrical engineer?

Name: _____

The Power of Wind

Engineering Design Process Sheet

ASK

What is the problem we are going to solve?

IMAGINE

Brainstorm solutions to the problem above.
Record your ideas in words or pictures.

Name: _____

PLAN

Create a blueprint of the prototype you will build.
What materials will you use?

CREATE

You will have _____minutes.
Use this time to build the prototype you planned.

Name: _____

IMPROVE

Edit the prototype that your group made.

Explain the changes that your group made to your model.

Why did your group make these changes?

COMMUNICATE

Share your prototype with the class or another group.

What was the most difficult part of this challenge?

What was the most successful part of this challenge for your group?

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IMAGE AND CONTENT CREDITS

Images

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Content

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