Design Sails for Sailboats & Windsurfing Boards

Kindergarten Guam STEM Design Challenge

Anchor Question: How can you design sails for sailboats and windsurfing boards that cause them to sail faster and farther on windy days?

Overview

Guam Connection

Watercraft are very popular to use. We can watch people in boat and board competitions and practices. When you watch boats or boards moving across the water with sails, you will notice that some go faster than others. Why is that? Not all sails are alike.

Engineering Design Challenge

Water activities that use sails to move across the water are common on Guam. When you go to the beach, you might see traditional and competitive proas, large and small sailboats, and windsurfers on their boards. Design the sail for a boat or board that causes it to sail faster and farther on a windy day. The sails can be different sizes, shapes, and direction to the wind on the same size boat or board.

NGSS Performance Expectation

K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or directions of pushes or pulls on the motion of an object.

K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull. [Assessment Boundary: Assessment does not include friction as a mechanism for change in speed.]

STEM Concepts (NGSS Disciplinary Core Ideas)

PS2.A: Forces and Motion ▪ Pushes and pulls can have different strengths and directions. Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it.

PS2.B: Types of Interactions ▪ When objects touch or collide, they push on one another and can change motion.

PS3.C: Relationship Between Energy and Forces ▪ A bigger push or pull makes things speed up or slow down more quickly.

ETS1.A: Defining Engineering Problems ▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

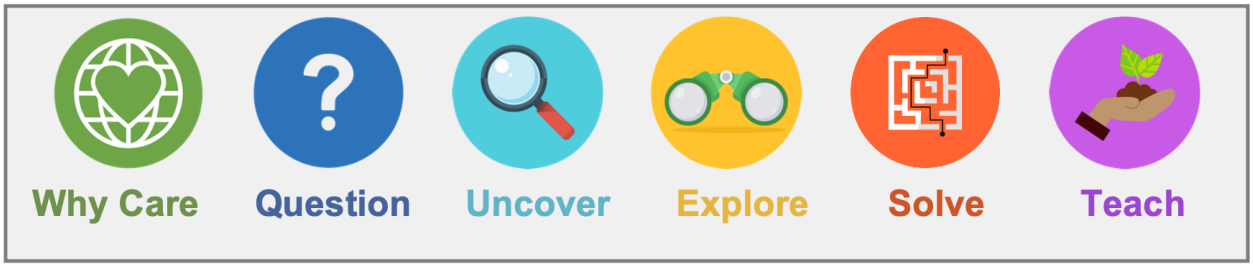
Time: Estimated Number of Classes

__ - __ classes (45-minute class)

Materials for the Design Challenge

Intro Activity: corks, nails, foam squares, rubber bands, toothpicks, foil
Design Activity: base/mast for vessel, bin for water (under bed tray), fan
Sail Materials: foil, paper, cardstock, paper cups, wax paper, items from home, masking tape

The Q-U-E-S-T Experience



Why Care?	What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?
Question	Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.
Uncover	Learn the science ideas needed to understand the problem and design a project to solve the problem.
Explore	Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.
Solve	Use the engineering design process to design and do a project that helps SOLVE the problem.
Teach	Share your project with others to help others understand the problem and how your project helped solve it.

Why Care?

What is the problem, anchor question, and design challenge? How is this relevant and interesting to us and where we live?

Introduce the Quest

1. **Post and read the anchor question:** How can you design sails for sailboats and windsurfing boards that cause them to sail better (faster and farther) on windy days?
2. **Read, describe, and post the design challenge:** Design the sail for a boat or board that causes it to sail faster and farther on a windy day. The sails can be different sizes, shapes, and direction to the wind on the same size boat or board.
3. **Share and talk about the Driving Question for why we should care:** How does the wind affect the speed and direction of different sailboats and waterboards? How does understanding this help keep me safe on a boat and increase my ability to control the speed and direction of my watercraft?
4. **Read, watch videos, and discuss** current uses of windsurfing boards and sailboats on Guam and any other local issues, competitions and uses by residents and tourists you are aware of. Guam is surrounded by water. Many people that live on Guam engage in watercraft use for both sport and for jobs like fishing as do the tourists that visit.

a. Ask for ideas to get students thinking about how they and their families use sailboats and sailboards.
b. Share a personal story or experience you have had with watercraft (both good and not so good)
c. Ask students if they or a family member also has a story to tell.
d. Choose and show video clips of watercraft with sails.
    i. Windsurfing in Guam
    ii. https://youtube.com/shorts/Ac0jFPyiiNc?feature=share
    iii. Sailing off the Coast of Guam
e. Show photos of different shapes and sizes of real sails.

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Write or draw your "why I care" and why others on Guam care.

Question

Begin by asking QUESTIONS about the problem and ways to solve it. Figure out what you already know, and brainstorm what you could do.

Ask Questions

1. **Create a KND Chart (Know, Need to know, Do)** with the three driving questions below. You will want to save the questions and responses to look at during the QUEST; writing them on chart paper, butcher paper, in student design notebooks, or use a digital organization chart, like Jamboard. KND Questions:
    a. What do we **KNOW** already about sails and how they affect the movement of watercraft?
    b. What do we **NEED TO KNOW** to design a sail for a watercraft that increases its speed?
    c. What could we **DO** to design a sail to move a sailboat or other watercraft a distance of one or two meters and faster?
2. **Gather responses from students.** Have students think and write responses: First, silently and individually. Then, in small groups. And finally, with the full class. The end result is a class KND chart to refer to, add to, and reorganize throughout the QUEST. Students could sort the responses that are similar. This information will help guide the UNCOVER and EXPLORE.

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Write KND lists. Organize the questions (Need to Know) from class. Record the categories, or themes, of the questions and ones you are most interested in.

Uncover

Learn the science ideas needed to understand the problem and design a project to solve the problem.

Uncover Key Ideas

1. **Share the Driving Question:** What makes things move and what makes them stop?
    a. Activity: Students will watch a video, and then use a game (rolling balls) to explore how pushing and pulling affects an object's motion.
    b. Video lesson everyday push-pulls: FORCE & MOTION How Things Move *Explained* | Science for Kids!
    c. After the students conduct investigations as groups, have them summarize their observations and develop an explanation using the terms collisions and pushes on one another.
2. **Share the Driving Question:** What's a push and pull and how does it cause objects to speed up or slow down?
    a. Activity: Students will play tug of war with a rope, and they will play rolling games with a ball to explore pushes and pulls.
    b. Push and Pull https://www.sciencebuddies.org/teacher-resources/lesson-plans/push-pull
    c. Activity: Play tug of war and ball rolling games to:
        i. Categorize actions as either pushes or pulls.
        ii. Demonstrate, explain, and predict how pushes and pulls can start, stop, or change the direction of an object's motion.
        iii. Demonstrate, explain, and predict how a stronger push or pull can create a bigger change in an object's motion.
    d. After the students conduct investigations as groups, have them summarize their observations and develop an explanation using the terms pushes and pulls and how they affect the speed of an object.
3. **Share the Driving Question:** What does the engineering process look like?
    a. Activity: Students listen to the story of Papa's experience with the engineer process (failing) until he has a functioning vessel
    b. Papa's Mechanical Fish Read Aloud

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Write the driving question and summarize what you did and learned. (blank page)

Students will understand these NGSS Disciplinary Core Ideas:

PS2.B: Types of Interactions ▪ When objects touch or collide, they push on one another and can change motion.
PS3.C: Relationship Between Energy and Forces ▪ A bigger push or pull makes things speed up or slow down more quickly.
ETS1.A: Defining Engineering Problems ▪ A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.

Explore

Apply what you've learned in Uncover to EXPLORE the problem in your community and consider project ideas to solve the problem.

Apply Your Learning

1. **Share the Driving Question with students:** How can we apply what we learned in UNCOVER to understand the problem in our community and to come up with project ideas to help solve the problem?
2. **Revisit the KND lists** you wrote at the beginning of your Quest. Add and edit them to include new understandings and experiences from UNCOVER.
    a. KNOW - What have you confirmed as accurate? Correct any inaccurate information.
    b. NEED to know - Mark any questions that you have answered, and ones you still need and want to answer. Add new questions.
    c. DO - Add any new project ideas you could do to help solve the problem.
3. **Return to the anchor question:** How can you design sails for sailboats and windsurfing boards that cause them to sail better (faster and farther) on windy days?
4. **Read and talk about the design challenge:** Students create simple vessels using prototypes and test them. This activity provides students with an understanding of the parts of a sailboat. DIY Toy Sailboat (Science Buddies)

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- Design Challenge Map- Complete as much as you can. Then add to and edit it throughout SOLVE.
- Design Requirements and Limitations (criteria and constraints)

Solve

Use the engineering design process to design and do a project that helps SOLVE the problem.

Teacher prep: Consider how you want students to design the project: How do you want students to go through the engineering design process to design and complete a project to SOLVE the problem? How will they choose one design to create, test and collect data about, then refine, and test again? How do you want them to defend their most effective design?

Design & Do Your Project!

1. **Driving Question:** How can I create and test a sail design to move the boat through water quickly?
2. **Investigation:** Students investigate different materials and design a sail to move a vessel (foam base) one or two meters faster. How can you design a sail to move the boat faster through the water? Instructions for the design challenge are here: Designing a Sail: Science and Children. Your steps will follow the engineering design process: (Poster: Engineering design challenge process)
    a. Design: Which material would be better for the sail? What size would it be? How is it attached? Does it move?
    b. Test: Students test which material is best for sailing.

c. Evaluate: Students choose the material that created the best sail.
d. Redesign: What size sail is best for the vessel provided?
e. Test: Students test different sized sails (from their best material).
f. Evaluate: Students choose the sail size that created the best sail.
g. Redesign: What shape is best for the sail?
h. Test: Students test different shaped sails (using the same size that was chosen).
i. Evaluate: Students choose the sail shape that created the best sail.

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- Edit and complete the Design Challenge Map.
- Edit and complete the Design Requirements and Limitations (criteria and constraints)
- Action Plan: List steps to complete the project, and who will do what.
- Team Self-Review: Review your project design to make sure it is focused on the design challenge, anchor question, and Guam.
- Gathering Feedback from Others: Get input from others to help strengthen your project.
- Claim-Evidence-Reasoning (CER): Give evidence for the most effective project design.

Teach

Share your project with others to help others understand the problem and how your project helped solve it.

Share & Reflect on What You Learned

1. **Return to the anchor question:** How can you design sails for sailboats and windsurfing boards that cause them to sail better (faster and farther) on windy days?
2. **Students creatively share their project and how it helped solve the problem:**
    a. Who's your audience? Who will benefit from hearing about and seeing your project?
    b. How will you share this information?
    c. What do you want them to know and understand about the problem, how you collected data, your project and its impact?
    d. When and where will you share?
3. **Student reflection:** After teaching others, students can do a reflection about their Design Challenge. Here's an option: 4-3-2-1: Looking back, planning forward. Respond to:
    a. FOUR of the most important things I learned doing this design challenge.
    b. THREE of the most important things I learned about myself doing this design challenge.
    c. TWO things I will do differently in my next problem-solving experience.
    d. ONE thing I now want to learn more about.

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- TEACH. Make a plan for sharing your project with others.
- Looking back, planning forward. Reflect on what you did and what you might do next time.

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