3 Our First Sail Designs

Build Knowledge

INTRODUCTION

What Students Do in This Activity

As a challenge pretest, each student designs a sail and writes down his or her thinking for the design. Design teams meet to share their thinking and then, as a group, determine a shape they think would make their first sail design a good one. The initial focus is on making the skimmer go far and straight. They draw the sail on an index card, cut it out, trace it on a sheet of graph paper, determine its area, and attach the sail to their skimmer. They also learn how to use the Skimmer Test Log to record their test results. Each team then tests its skimmer's performance using the log to record data on each sail design.

Rationale

The pretest provides both baseline information on each student's current knowledge and thinking about the challenge and initial designs for the teams to consider. Students learn or review how to find the area of a shape, giving them a strategy for measuring and comparing their sails. Design teams make and test their own sails. Each sail's performance will vary. This furnishes data for the discussion in the following activity, where students will see the need for controlled experimentation to better understand the effects of sail characteristics on the skimmer performance. The Design Team Evaluation encourages students to reflect upon their individual contributions to the team's work.

Time

2 class sessions, or 1 double period

Materials

for each student:

- Skimmer Sail Drawing, Reproducible Master 7 (pretest)
- Design Team Evaluation, Reproducible Master 12
- centimeter ruler

for each design team:

- Making a Sail, Reproducible Master 8
- several sheets of index cards
- several copies of the Skimmer Test Log, Reproducible Master 9
- Sample Skimmer Test Log, Reproducible Master 10 (optional)
- copies of Centimeter Grid Paper, Reproducible Master 11, or centimeter graph paper

for the class:

- scissors
- masking tape
- large paper clips
- drinking straws
- overhead projector (optional)
- overhead made from Centimeter Grid Paper (optional)
- overhead made from Sample Skimmer Test Log (optional)

Preparation for the Activity

Prepare skimmer testing areas as in the previous activity. Have 3 x 5 index cards available for Finding the Sail Area. Cut out a non-rectangular oaktag sail and trace its outline on the centimeter graph paper in preparation for showing students how to estimate the area of any sail.

CLASSROOM ACTIVITY

Assessing Initial Student Knowledge

Discuss the results of their testing of the skimmer and 3 x 5 index-card sail from the Building the Skimmer activity. Ask students for suggestions as to what they think might make the skimmer go farther. Explain that the next step (of the design experience) is to give them a chance to explore their ideas for making and testing their sails.

Teacher Tip:

Consider doing this section of the activity during mathematics class time.

Give each student a copy of Skimmer Sail Drawing, Reproducible Master 7, which is the Skimmer Challenge pretest, and a centimeter ruler. Have students fill in this sheet on their own. They are to draw a sail on the paper, label the sail dimensions in centimeters on their drawing, and write an explanation as to why this sail will move the skimmer farther.

Finding the Sail Area

The area of a sail is a characteristic students will be testing throughout this challenge. When comparing the results of their different sail designs, they will need to know the area of each sail the design teams test. Discuss how to find the area of the sails. One way for students to verify area of the sails is to trace the sails on centimeter graph paper. Ask students how they might estimate the area of a sail traced on centimeter graph paper.

Students may suggest finding the area of rectangular shapes (including squares) by counting the number of centimeter squares inside the shape. Some students may know the formula for finding the area of a rectangle and suggest multiplying the length and width.

Encourage students to suggest how to estimate the area of sails of non-rectangular shapes, such as triangles, trapezoids, or curved shapes. Use a transparency of the centimeter grid paper and draw a triangular "sail." Ask students how they might find the area of the sail. They may suggest that they can find the area of the whole centimeter squares inside the shape by counting them, record the total area of the whole squares and then estimate the total area of the partial squares. Another way is to first tally the number of pairs of partial squares whose combined area is approximately equal to 1 square centimeter. Record the total area of the partial squares. Finally, add the partial sums to find the total estimated area. Some students may notice that the triangle is half of a square. Note that some students may already know formulas and should use them if they understand how to do so.

Distribute 3 x 5 index cards and centimeter grid paper and ask students to estimate the area in square centimeters. After students have figured the area, ask student volunteers to share with the class how they arrived at their answers. Note that students may have different strategies which is fine as long as their answers are close.

Teacher Tip:

Be sure to collect and review the students' completed Skimmer Sail Drawing, Reproducible Master 7, to get a sense of their understanding of the design challenge. This sheet can be saved in individual student logs, if you have them, or in the Design Team Logs.

Designing and Making a Preliminary Sail

Distribute Making a Sail, Reproducible Master 8, to each design team. Go over the steps teams will follow. Emphasize that all team members should participate in the brainstorming before the team as a whole decides on a sail to test. Each team should agree first on the goal for its first sail design. Is the goal to get the skimmer to go far, or to have a particular path? Teams should consider both the size and shape of a sail that they think will give their skimmer the path they want it to have. Students can use tape to attach the sail to a straw and mount the straw on the sail stand as they did in the last activity.

Testing the Skimmer

Distribute a Skimmer Test Log to each design team. Use an overhead transparency to discuss how to use the Skimmer Test Log to record test results. A Sample Skimmer Test Log, Reproducible Master 10, is available. Students can leave the first line, Characteristic We Are

Testing, blank for now. (Later in the challenge students will list here the specific characteristic of the skimmer they are testing.) Call students' attention to the "Other Information" heading at the top right. They should use the space below it to record the skimmer features and settings that they think are important to pay attention to as they test.

There are three rows where students will record three trials. Ask students why they think this might be important. They may already appreciate that the skimmer can be erratic from one trial to the next. Performing only one trial may give misleading information. Performing multiple trials of each test gives a better chance of getting a more accurate picture of how the skimmer performs.

Review the procedure for how design teams will share the testing stations and the roles of each team member.

Design teams may have time to make and test several sail designs. Let teams know that they will be sharing their test results with the class, so they should try as many different kinds of sails, including different sizes and shapes, as they have time to do. They might be surprised by what works and what doesn't.

Many students will want to design as large a sail as there is material available. Do not discourage this, but stress that they observe carefully and record what happens to their skimmer. They will find that sails that are too large tend to make the skimmer unstable, as the force of the air will tip the skimmer over. This observation will be important later when the class discusses the effects of sail size on the forces that make the skimmer move.

Be sure students find the area and complete a Skimmer Test Log for each sail they test. Design teams should keep the completed Skimmer Test Log sheets in their Team Design Logs.

ASSESSMENT

Give students the opportunity to self-assess their skills working in a team as well as gain insights into how students perceive their roles within their team. Design Team Evaluation, Reproducible Master 12, can be given to students immediately after the activity or as homework.

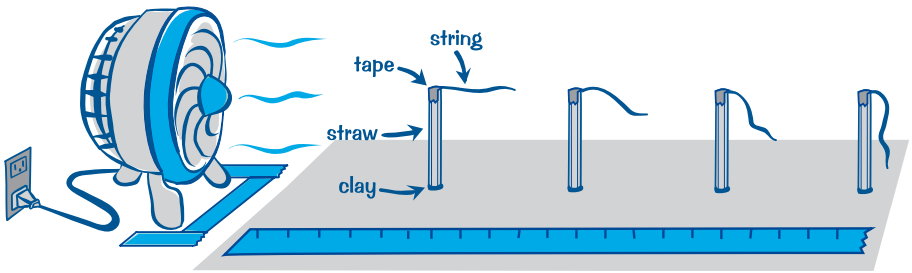
Teacher Tip:

Use the evaluation sheet regularly throughout the challenge or adapt it to suit your classroom needs.

EXTENSION IDEAS

Looking at Airflow

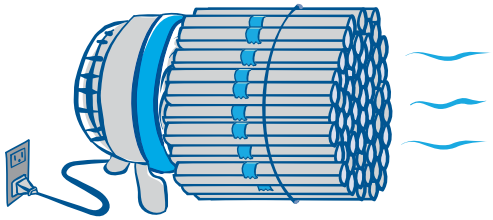
Airflow is not visible except as it causes things to move. To help students visualize the airflow coming off the fan, set up a series of straws and streamers at regular intervals in front of a fan.



For wands, use a set of drinking straws. Set them upright in a clay or tape base 30, 60, 90, and 120 centimeters from the front of the fan. For streamers, use strips of string tissue paper approximately 15 centimeters long taped to the top of the wands. When the fan is turned on, the airflow will make the streamers flutter. Those closest to the fan will flutter more strongly, indicating a stronger airflow.

Make an Airflow Straightener

The air from the fan spreads out in a V-shape as it leaves the fan. To focus the airflow into a straighter line, students can make an airflow straightener from a bundle of paper tubes.



Each tube is a sheet of 8.5- x 11-inch paper approximately 1 inch in diameter secured with a small piece of tape. (Try to use paper from the recycling bin.) A large rubber band holds the tubes in a bundle. Place the bundle in front of the fan so that it covers the blade area. The skimmers will move farther and faster.

Area

Explore the concept of area in mathematics class. Review any area formulas the students have seen. Give students a set of shapes to find the area of using different methods.

Name _____ Date _____

SKIMMER SAIL DRAWING

1. Draw a sail that you think will make the skimmer move the farthest. Label the sail dimensions in centimeters.

2. Explain why you think this sail will help the skimmer go far.

_____

_____

_____

_____

_____

MAKING A SAIL

1. Complete your own Skimmer Sail Drawing.

2. Sketch the sail drawing on an index card (you may use more than one index card, and tape them together).

3. Cut out the sail.

4. Trace your sail outline on a sheet of centimeter graph paper.

5. Find the area of your sail in square centimeters. Write the area (or estimate) on the sail.

6. Use tape to attach the sail to a straw mast.

Team Members_____ Date _____

SKIMMER TEST LOG

Characteristic We Are Testing:

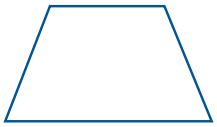
Sail Drawing	Sail Area	Other Information

Trial	Distance	Observations
1		
2		
3		

Team Members_____ Date _____

SAMPLE SKIMMER TEST LOG

Characteristic We Are Testing:

Sail Drawing	Sail Area	Other Information
	194 sq. cm	Sail stand is at 8 cm. Sail height is 3 cm above the hull.

Trial	Distance	Observations
1	105 cm	Went pretty straight until the end, then it turned to the right. Sail bent a little from the wind.
2	90 cm	It was stopping and starting at the end.
3	100 cm	Pretty much like the first trial, but a little slower.

Name _____ Date _____

DESIGN TEAM EVALUATION

Today our team worked on:_____

_____

_____

_____

Today my job title was: _____

_____

I contributed to the team's work today by:_____

_____

_____

_____

Circle Yes, No, or Sometimes to the following statements:

Today everyone on the team

knew what his or her job was	Yes	No	Sometimes
helped each other understand the jobs	Yes	No	Sometimes
did his or her job	Yes	No	Sometimes
contributed to the team's work	Yes	No	Sometimes
listened to each other	Yes	No	Sometimes
stayed focused on the work	Yes	No	Sometimes
completed the work	Yes	No	Sometimes

Next time our team could work better if: _____

_____

_____

_____

Today I learned that: _____

_____