HOW MUCH WATER WOULD WOOD ABSORB IF WOOD WOULD ABSORB WATER? LESSON 1: PERCENT CHANGE

INTRODUCTION

Composite materials are materials, either engineered or naturally occurring, made from two or more materials with significantly different physical or chemical properties that remain separate and distinct in the composite material. Wood is a composite material used in aircraft. Students will collect the dimensions and weight of wood samples before and after immersion in water. Half of the wood samples will be painted to emulate protective coatings used in building aircraft. Students will use their data to calculate the volume of the wood samples before and after immersion. They will find the percent change in weight before and after immersion. They will use this information to determine if painting the wood has an effect on water absorption.

LEARNING OUTCOMES

- Students will be able to accurately calculate percent change in weight by accurately weighing wood samples before and after water immersion.
- Students will be able to determine if painting the wood affects water absorption.

CURRICULUM ALIGNMENT

COMMON CORE STANDARDS – 7TH GRADE MATHEMATICS

7.R Ratios and Proportional Relationships
Analyze proportional relationships and use them to solve real-world and mathematical problems.

3. Use proportional relationships to solve multistep ratio and percent problems.

CLASSROOM TIME REQUIRED

One or more 55-minute classes

TEACHER PREPARATION

The teacher will need to obtain wood prisms and/or cylinders. End grain balsa wood is good to use since it absorbs water quickly and is relatively inexpensive at craft stores. Any other types of wood can be used. To create the wood sample cylinders use different diameters of dowels and cut them into several cylinders. Paint half of the wood samples.

MATERIALS NEEDED

- Different types of wood samples and pictures of products made from those types of wood
- Wood prisms and wood cylinders
- Immersion containers – plastic cups large enough to completely submerge the wood samples in water.
- Water
- Scale
- Rulers or calipers
- Paper towels
- Calculators
- Large paper to record class data
- Hand-outs: Class Data Sheet and Lesson 1 Assessment

TECHNOLOGY RESOURCES

Students will need calculators. The teacher will need a computer with projector to display images of types of wood.

PRE-ACTIVITIES FOR STUDENTS

Students will need to know how to calculate percent change as well as how to use a scale.

ACTIVITIES

EXPLORATION

1. Give student pairs pictures of several different types of wood samples.
   Ask students to discuss types of products for which they think each type of wood is used.
   Call on students to share their responses.
2. Hand out cards with pictures of different products made from wood and ask student pairs to match the type of wood with a product
3. Use a computer projector or document camera to display the images of each type of wood. For each, call on students to ask what product they think the wood could be used for.
4. Show the pictures of the type of wood and matching product cards and ask if any students are surprised at the results.

DATA COLLECTION

Demonstrate data collection for the class:

1. Weigh a dry wood sample and record the weight on the board.
2. Place a wood sample in the immersion container and pour water over the sample until it can be completely submerged.
3. Since wood floats, students will notice the sample is not completely submerged.
4. Ask students for ideas to keep the sample submerged.
5. Students will likely say to hold the samples under water with an object.
6. Ask students what type of object could be used. They might say a pencil, pen, or finger.
7. Ask how that might be used to keep the samples submerged. They should answer by holding the object on the wood sample to keep it submerged.
8. Demonstrate how to use your finger by placing it on top of the sample and holding it there for 1 minute.
9. After 1 minute remove the sample. Use a paper towel to remove the surface water.
10. Weigh the wet sample and record the data on the board.
11. Use your data to demonstrate how to calculate the percent change of the dry sample weight and the wet sample weight. (You can use your actual data.)

Example 1: Find the percent change in weight using the sample data below.

dry weight = 5.1 g wet weight = 7.4 g

Step 1) Calculate the difference between the wet weight and the dry weight.

$$7.4g - 5.1g = 1.7\ g$$

Step 2) Divide the difference from Step 1 by the original (dry) weight.

$$\frac{1.7}{5.1} = .30$$

Step 3) Change the decimal answer form Step 2 to a percent by multiplying by 100.

$$.30 \times 100 = 30$$

Step 4) Round answer from Step 2 to the nearest whole number.

Step 5) Write your final answer as a percent. The percent increase in weight is 30%.

Example 2: Find the percent change in weight using the sample data below.

dry weight = 8.2 g wet weight = 10.4 g

Step 1) Calculate the difference between the wet weight and the dry weight.

$$10.4\ g - 8.2g = 2.2\ g$$

Step 2) Divide the difference from Step 1 by the original (dry) weight.

$$\frac{2.2}{8.2} = .2683$$

Step 3) Change the decimal answer form Step 2 to a percent by multiplying by 100.

.2683 x 100 = 26.83

Step 4) Round answer from Step 2 to the nearest whole number. 26.83 rounds to 27.

Step 5) Write your final answer as a percent. The percent increase in weight is 27%.

Students collect their own data.

1. Give each pair of students one unpainted wood sample and one painted wood sample.
2. Discuss with students why the wood is painted.
3. Give each student a data collection handout.
4. Have students work in pairs to weigh the dry wood samples and record the results on the handout.
5. When each pair of students has weighed and recorded their data, give them an immersion container with water.
6. Ask the students to completely submerge their samples, one at a time, in the water as you demonstrated earlier.
7. Remind students to keep the sample submerged for 1 minute.
8. Using a paper towel, students remove the surface water from each sample.
9. Student pairs will weigh their samples and record the values on the handout.

CONTENT WRAP-UP

1. Ask one student from each pair to write their data on the class data sheet. (Use a large piece of paper posted at front of class or a spreadsheet displayed with a computer projector. This will allow you to use the data later.)
2. Once all data is on the class data sheet, ask student pairs to discuss what they notice about the data. Allow two minutes.
3. Ask the students to share what they have noticed and record this on board.
4. Lead students to observing that the weights are not the same for all types of wood even if they are the same size.
5. Discuss why that might be: "What do you notice about the weight of the dry and wet samples?"
6. All wet sample data may not be significantly different from the dry sample data. Ask students why this might be.
7. Students should mention the different types of wood from the Exploration. Explain that differences may exist even if we cannot observe them. Using other more precise methods of observation or measuring tools allow researchers to determine differences.
8. Have students calculate the percent change in weight of their samples. Remind students how to calculate percent change by referring to the example on board.
9. Tell students to find the "change in weight before and after water immersion". Change = (wet weight – dry weight). Then, divide the "change" by the original (dry) weight. (Change/Dry Weight). Write your answer as a

percent by multiplying your answer by 100%. Keep at least one example posted for students to see. Walk around classroom to identify student misunderstandings such as dividing by the wet weight instead of the original dry weight or getting a negative change

10. Have one student from each pair record their percent change in weight on the class data sheet.
11. Ask students what they notice. Is there any difference in the percent change for painted versus non-painted wood? Painted wood should have a smaller percent change in weight than unpainted wood.
12. Ask students how they think water absorption affects aircraft. Students should conclude that unprotected wood would make the aircraft heavier and more expensive to fly in the rain. Protecting the wood with a water resistant material increases the efficiency of the aircraft.

GUIDED PRACTICE

- Allow students to work independently on the *Guided Practice Handout*.
- When all students have finished the worksheet, ask them to explain to their partners the calculations for percent change. Select several students and ask them to demonstrate for the class how they found the percent change in weight.
- Ask students not presenting to raise their hand if they see an error. The presenting student may call on students to discuss the error.

ASSESSMENT

Administer the Lesson 1 Assessment as a quiz at the end of the lesson.

MODIFICATIONS

This lesson plan is intended for students in Accelerated 7^{th} Grade Math or a pre-Algebra equivalent. Teacher can provide more scaffolding for special needs students and English language learners. Assigning a partner who can help will make group work more effective. The teacher should make sure to monitor students requiring additional help. An additional handout is provided for gifted learners. Gifted learners may also be given another set of wood samples such as oak or maple.

CRITICAL VOCABULARY

Percent change: the relative change between two values or measurements.

WEBSITES AND RESOURCES

Water immersion effect on swelling and compression properties of Eco-Core, PVC foam and balsa wood
http://www.sciencedirect.com/science/article/pii/S0263822309000919

Putting it together – the science and technology of composite materials.
http://www.science.org.au/nova/059/059key.htm

Video clips about the composite Eco-Core provided by North Carolina A & T State University

COMMENTS

A sample data set is provided for teachers without access to the materials needed. Of the woods tested, balsa wood showed the largest percent increase. Harder woods such as maple showed very little change.

AUTHOR INFO

Carol L. Taylor is a 7th grade math teacher currently at Hanes Magnet School in Winston-Salem/Forsyth County Schools. She has over ten years of classroom experience as well as several years working as a Biostatistician for Wake Forest School of Medicine. Mrs. Taylor has a Bachelor of Science degree in Mathematics from Miami University (OH) and a Master's of Applied Statistics degree from Ohio State University. She is a National Board Certified Teacher, Kenan Fellow, and a recipient of the 2009 Edyth Sliffe Award for Excellence in Middle School Mathematics Teaching.

As part of her Kenan Fellowship, Mrs. Taylor worked at the NASA Center for Aviation Safety in the Center for composite Materials Research, Department of Mechanical Engineering at North Carolina A&T University. Her mentors were Kunigal N. Shivakumar, Ph.D., Director and Research Professor, and Robert Sadler, Adjunct Research Associate Professor.

ACKNOWLEDGEMENT

Lesson developed through the Flight Fellowships: STEM in Aerospace Science and Aeronautics, a program of the Kenan Fellows Program and the North Carolina Science, Mathematics and Technology Education Center.

Funding provided for the Flight Fellowships by NASA K-12 Cooperative Agreement #NNX10AU89A.

KENAN FELLOWS PROGRAM

North Carolina Science, Mathematics, and Technology Education Center