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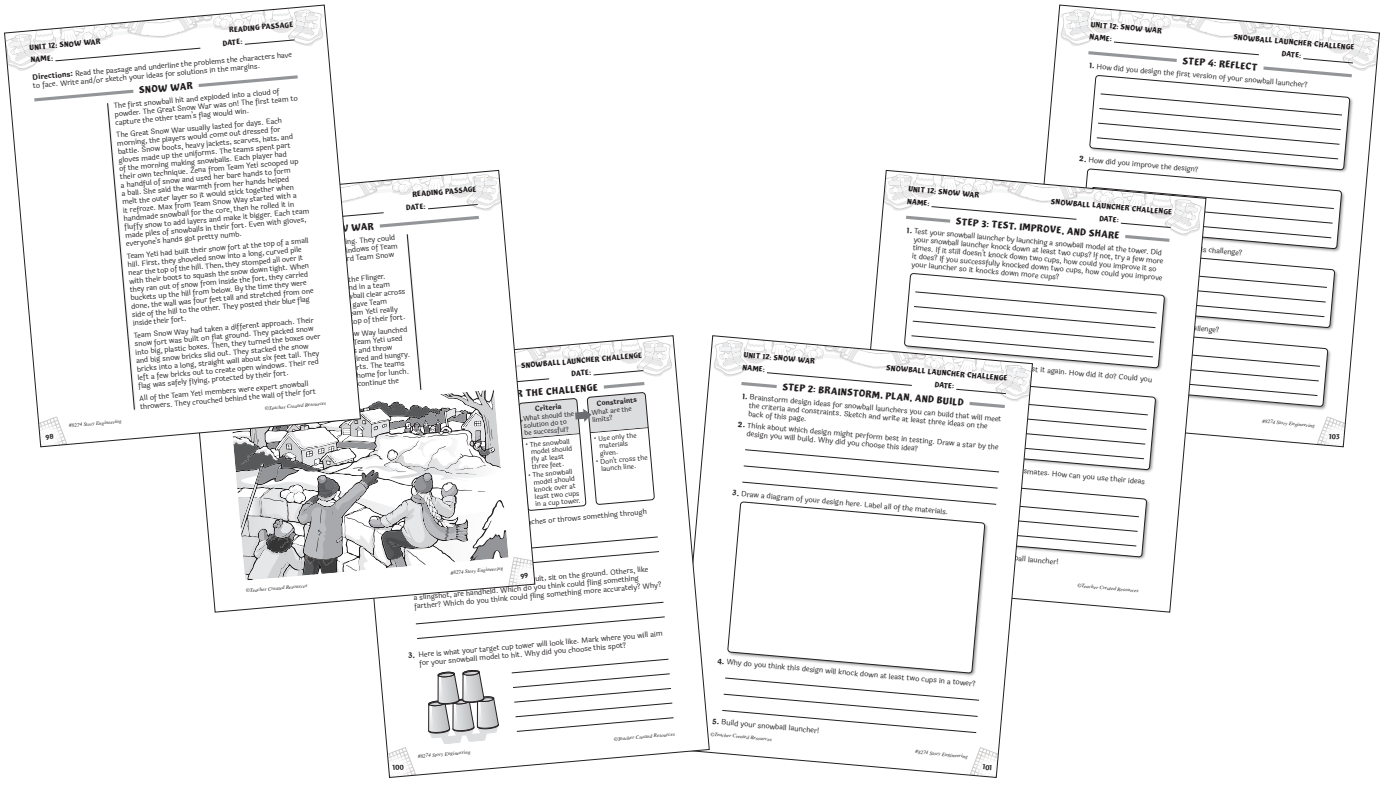
INTRODUCTION

This book will help you implement engineering design challenges in your classroom by using stories as an entry point. This interdisciplinary approach helps students contextualize engineering and design concepts, and they will get excited about engineering!

The stories are fun and engaging and have been specifically developed to include several problems—some obvious and some not so obvious. Students read a story and look for and discuss the problems they find, which encourages them to reread and analyze the text of the story. Once students have chosen a problem, they work in teams to define what they need to create to solve it. Teams then use the engineering design process to plan, build, test, and improve their solution using recycled materials and common supplies. Finally, students reflect on their experience through writing. This integration of literacy and STEM allows students to acquire and practice skills in both areas.

Engineering challenges may be different from what you and your students are used to. Instead of lecturing or demonstrating, you will be putting materials in the hands of students, setting them up for success, and turning them loose to create and build. You become a facilitator—scaffolding when necessary; providing guidance; and checking in with groups to offer encouragement, advice, correction, and support. Motivate students to help one another, both within teams and between teams.

There may be a bit of a learning curve at first, but once students understand how engineering challenges work, they really dive into them. They become fully engaged in working together on their own terms, manipulating materials, and solving a compelling problem, with their hands and minds occupied and on task. And these challenges are not conducive to silence; a low buzz of purposeful conversation indicates that students are actively engaged. Your biggest problem may be getting them to wrap things up!



MATERIALS:

Required: cupcakes with frosting (If you cannot use actual cupcakes, create cupcake shapes from clay or salt dough and top with shaving cream "frosting.")

Suggested: container materials such as plastic cups and bowls, empty food containers, small cereal boxes; structural materials such as craft sticks, toothpicks, straws, cardboard; connecting materials such as tape, pipe cleaners, rubber bands

PREPARATION:

Set up a testing course for students to walk through while carrying their cupcakes. The more obstacles you add, the harder it will be for the cupcake to make it through unchanged! Some ideas for obstacles: go over a chair, go under a table, turn around in place three times, hop or jump along a masking tape line. Students can help set up the course.

LESSON PLAN:

1. Have students read the passage and discuss the problems they identified. Use these questions as prompts:
   - Have you ever baked anything? How did it go? What problems did you have? How did you solve them?
   - Did Darrel have problems in this story? How did he solve them?
2. Introduce the Cupcake Carrier Challenge by reading through the challenge pages together. Show students the available materials and review the criteria and constraints. Demonstrate (or have a student demonstrate) how they should walk the testing course.
3. Emphasize the criteria that the cupcake holders must allow the cupcakes to be put in and taken out quickly. Students can't close their carrier permanently once the cupcake is inside!
4. Give students time to prepare, brainstorm, plan, and build their cupcake carriers. Circulate to observe and answer questions as students work on their solutions. Remind them to use the challenge pages to guide them as they work through the engineering design process.
5. Have students share their solutions with the class and get feedback from peers, then revise their designs and test again.
6. When students have completed the challenge, have them explain their cupcake carrier designs to the class and demonstrate by walking the course. Then have them fill out the reflection page.
7. If time, allow students to choose their own problem and testing setup and use the *Universal Challenge Pages* (pages 104–107) to complete their challenge.

NAME: _____ DATE: _____

Directions: Read the passage and underline the problems the character has to face. Write and/or sketch your ideas for solutions in the margins.

BIRTHDAY BAKER

Darrel thought it would be great to make cupcakes for his friend Corbin's birthday, but he had never made cupcakes before. He had his grandma's recipe for chocolate cupcakes with chocolate frosting. He knew Corbin loved chocolate. Darrel took a deep breath and decided to give it a try.

First, he needed to measure out the ingredients. The recipe said, "Two cups of flour, sifted." What did that mean? He went to his computer and searched "how to sift flour." He learned that *sifting* means "shaking the flour through a screen." This breaks up any lumps and makes the flour lighter and easier to mix into the other ingredients. Only one problem: he didn't have a sifter. He measured out two cups of flour and stirred it a bit with a fork to break up the lumps.

The recipe called for two eggs. Darrel took a carton of eggs out of the refrigerator. As he turned to place the carton on the counter, he didn't notice his dog, Coco, behind him. He tripped over Coco, who bolted out of the kitchen. The entire carton of eggs flew out of Darrel's hand and landed on the floor. Oh, no! Thankfully, only some of the eggs broke. Darrel still had the two he needed for the cupcakes.

Once he had all the ingredients ready, Darrel moved to the instructions. He mixed together the flour, baking powder, cocoa, and salt in a bowl. Then, he read, "Cream together the butter and sugar until light and fluffy." Hmmm. Cream wasn't on the ingredient list. A quick search told him that it means to mix ingredients together quickly so little air pockets form. This makes the cupcakes fluffy. He also read that if he had an electric mixer, it would take three minutes to cream the butter and sugar. He didn't have a mixer, so he would have to cream the butter and sugar with a wooden spoon, which would take 20 minutes. By the time he was done, his arm was aching.

NAME: _____ DATE: _____

STEP 1: PREPARE FOR THE CHALLENGE

Problem What problem will you solve?	Challenge What will you do?	Criteria What should the solution do to be successful?	Constraints What are the limits?
Darrel put the cupcakes on a plate and covered them with foil. Some of the frosting stuck to the foil.	Design and build a cupcake carrier.	• The carrier should cover or enclose the cupcake completely. • The carrier should allow you to quickly put the cupcake in and take it out. • When carried through the testing course, the cupcake should remain unchanged.	• Use only the materials given. • You cannot stick anything into the cupcake. • There must not be any frosting stuck to the inside of the cupcake carrier.

Before you start designing your cupcake carrier, walk the testing course. Pay attention to each section of the course and think about what might happen to the cupcake as you are carrying it.

1. Which section of the course do you think will be the most difficult to go through without damaging the cupcake? Why?

_____

_____

_____

2. What does your cupcake carrier need to do to keep your cupcake safe in this section of the course?

_____

_____

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