Grade Level/Course: Grades 3-5 Next Generation Science Standards - Engineering and Design

Lesson/Unit Plan Name:
Design Challenge: Building a tall, strong tower

Rationale/Lesson Abstract:
This lesson will introduce students to the Engineering Design Process. Students will work as civil engineers to design and construct a tower from various materials that will withstand both a gravity and wind challenge.

Timeframe:
1-2 class periods

Common Core Math Standards

Grade 3:
3.MD.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.

Grade 4:
4.MD.1 Know relative sizes of measurement units within one system of units.

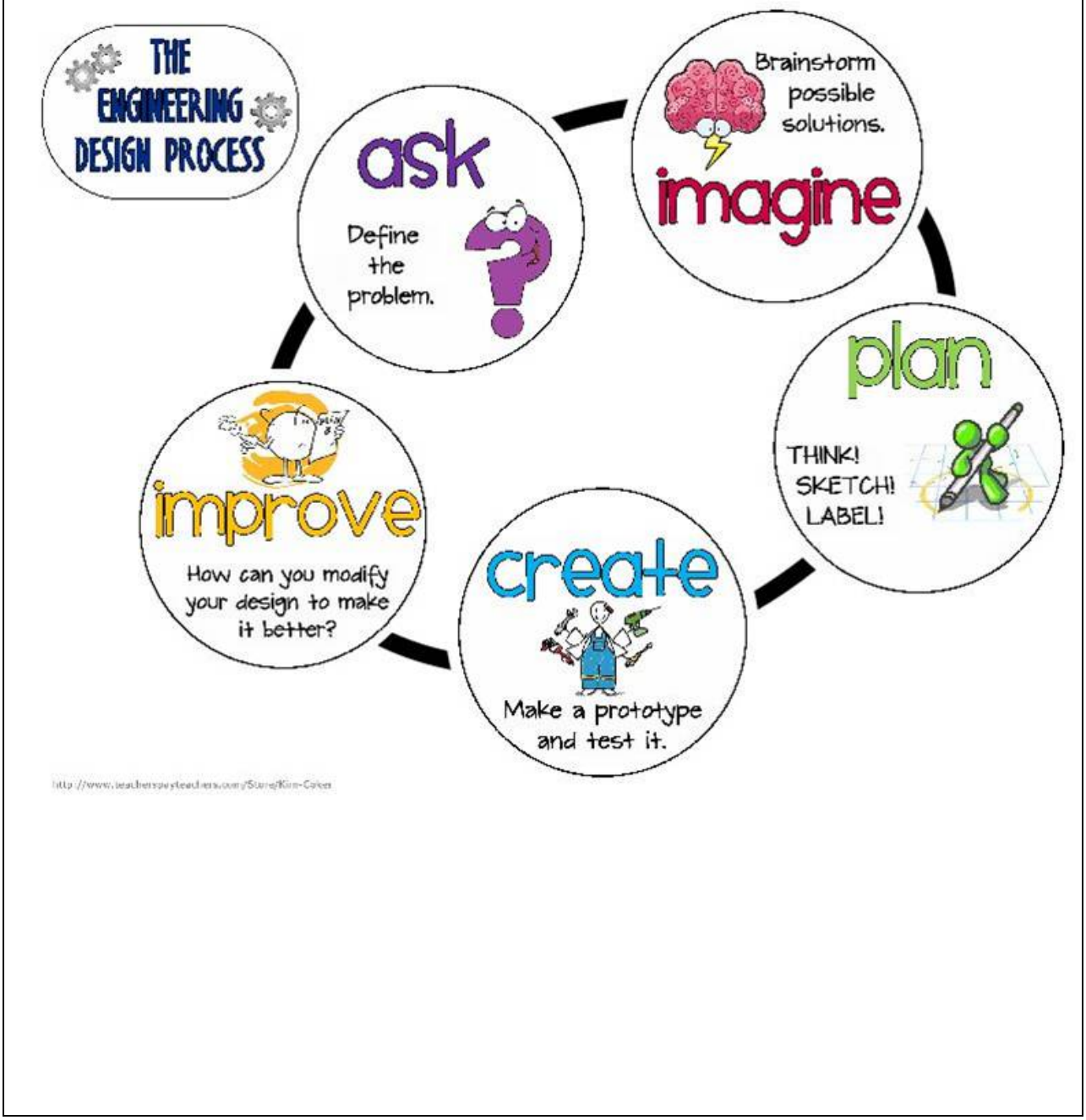
NGSS Standards:

Grade 3:
3-PS2 Motion and Stability: Forces and Interactions
3-PS2.A Each force acts on one particular object and has both strength and a direction.

Grade 5:
5-PSU Motion and Stability: Forces and Interactions
5-PSU.B: Types of Interactions
The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center.

Engineering and Design Standards Grade 3-5

3-5-ETS1 Engineering Design
3-5 ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5 ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5 ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.



Instructional Resources/Materials:

For Teacher:
Images of various kinds of towers to display or show to the class (attached).
Document camera or projection equipment (if possible)
White board and markers
Yardstick or measuring tape
Image of engineering design process
Portable fan

For each team of 2-4 students:
a plastic tray or piece of cardboard to use as a construction base
4-6 sheets of newspaper and recycled copy paper
4 wooden skewers
4 popsicle sticks
4 long plastic straws
two pieces of string (10 inches long)
masking tape or duct tape
a tennis ball
science notebooks
copies of 2-page Engineering and Design Writing Page (attached)
optional: measuring tape or yardstick per team.

Activity/Lesson-Part 1:
This lesson is adapted from a Design Squad activity. High Rise Challenge
It is simple, requires easily accessible and low cost materials and can be adjusted to teach to all elementary classes.

In this lesson, students will be introduced to the elementary engineering design process. Students will work in pairs or groups of four to design a tower that is at least 18 inches tall. Their constraints are the materials that they have to use and the time in which they have to design their building. When construction is completed, student buildings will be tested to see if their structures can withstand the forces of gravity and the strength of the wind. Students will record this activity on an Engineering and Design Process writing organizer.

First Day:
Students are introduced to the concept of the engineering and design model. Using the image, teacher will review the process with the class. In this lesson, students will work as civil engineers. Their task will be to design a tower at least 18" tall. The top of the tower must hold a weight (tennis ball) and the building should be strong and secure enough to withstand the wind of a portable fan. To ensure that students understand what a tower is – display on the document camera some of the examples of towers (or create your own slideshow).

Teacher should show students what materials will be made available to them to design the tower and explain that students will be working in engineering teams of twos and threes. Then each student should sketch or draw a picture of what their tower should look like.) Give students about 5 minutes to complete this task. Students should confer with their partners because they will eventually be building just one tower per team. Collect the pictures or have students put them in a safe place so that they can refer back to them during the second activity.

Local examples of towers are shown below. It would be helpful for students to see examples of towers for the purpose of this STEM engineering activity.

Activity/Lesson Part 2:

Before students start building, teacher will remind them of the design challenge – "How can you design a tower at least 18" in height that can withstand the forced of gravity (the weight of a tennis ball) and the strength of the wind (using a portable fan)?" Have them look at their drawings and remind them of the steps of the engineering design process before give them their materials. They should plan what they want to build. Students should take notes throughout this activity in their science notebooks.

Hand out the materials. Tell the engineers that they have 45 minutes to construct their tower. You may have to explain about bracing the newspaper with the sticks and straws or you may just want to let them figure out through trial and error. After 45 minutes, have engineers stop building. They may be ready to test their towers or they may need more time. If they are not finished, have students do a gallery walk around each table to see what other engineers have created. Emphasize that "sharing" ideas is very important in the engineering world.

When a few teams have completed their tower, start the testing process. Students must measure their tower to make sure that it is at least 18" tall. They must balance a tennis ball at the very top. And they must pass the wind test.

The final stage of the engineering design process is to "improve" (redesign) after a testing failure. Learning from mistakes is an important part of this lesson. Students should be given time to return to their desks and improve their tower – strengthen it, etc. and retest.

After all of the towers have been tested, the teacher should conduct a full class discussion about this activity asking guiding questions like:

What did you learn about the engineering design process?

What successes did you have with your tower?

What did you have to improve?

How well did you work with your team?

Assessment:

Students will complete a two-page organizer of their experience with the Engineering and Design Process. Teacher will conduct a full class discussion of this activity.

Names _____ Date _____

Planning Using the Engineering Design Process

The Problem is _____

_____

_____

_____

The Rules (criteria and constraints) are _____

_____

_____

_____

_____

My design idea is _____

_____

_____

_____

This is my design:

These are the materials needed: _____

_____

_____

_____

Test: Did it solve the problem? Explain: _____

_____

_____

_____

_____

_____

Improve: What did or could you change to make it better?

_____

_____

_____

_____

What did you learn? _____

_____

_____

_____

_____