STOP!
Please Read First: 5-8 Minutes

Before you begin the activity, please hand out the pre-test to each student. The pre-test has two different grade levels, make sure to use the correct one for your age group. The pre-test will help us evaluate how effective this unit is on teaching kids about the engineering method. At the end of the quarter the same test will be administered again to see how much knowledge students have gained.
Kindergarten-1st Grade

Draw and/or write about the 6 steps in the engineering process and put them in the correct order.

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Create a Model

Improve Your Model and Retest

Brainstorm Ideas

Explained what You Learned

Test Your Model

Think of a Problem

Test Your Model

Brainstorm Ideas

Explain what You Learned

Create a Model

Think of a Problem
<table>
<thead>
<tr>
<th>Process Grid:</th>
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<tbody>
<tr>
<td><strong>What is the Problem?</strong></td>
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<tr>
<td>Explain what You did and learned</td>
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<td>Test Your Model</td>
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<td>Criteria</td>
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<td>Constraints</td>
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<td>Problem</td>
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Unit 1: Engineer Design It

Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Objective(s):
Design a paper airplane that can fly and hit a target.

Instructor Notes:

Activity Instructions:

1. Put up a circle target on one wall (draw one on a piece of paper if you don’t have a pre-made one) and place a piece of tape 15 feet away from the target.

2. After students have designed their first airplane, have them go to the line and throw it. If it hits the target, can they stand farther away and still hit the target? If they didn’t hit the target, ask them what they might change to make their plane hit the target. Have them try out their ideas.

3. At the end of the lesson, have them reflect on the airplanes. Which airplanes were able to hit the target? What do they notice about those planes? If their plane didn’t hit the target, what was the problem? How could they fix that problem? What seems to be the overall best design?
Method 1:

1. **DIG. 1**

   Firstly fold the sheet in half along the line shown in DIG. 1 and then open it out again.

2. **DIG. 2**

   Fold the two top corners in to the center line to give the form in DIG. 2

3. **DIG. 3**

   Then fold the top large triangle over so that the two flaps formed in step 2 are underneath the large triangle. Your paper should now look like DIG. 3
Folding a Paper Airplane

- DIG. 4

4

From the form in DIG. 3 fold the two top corners into the center line again in such a way that you get the form in DIG. 4

1. DIG. 5

5

Now fold the small triangle up over the two flaps to give DIG. 5

- DIG. 6

6

Fold along the center line so that the small triangle is on the underside of the plane on the outside along with the two flaps as shown in DIG. 6

- DIG. 7

7

Fold along the line AB on DIG. 6 then turn the plane over and do the same to the other side producing DIG. 7.
Folding a Paper Airplane

Method 2:

1. **DIG. 1**
   
   Fold along the dotted line down the center of DIG. 1 then open the paper out and fold along the diagonal lines at the top to give DIG. 2.

2. **DIG. 2**

   Fold along the diagonal lines in DIG. 2 bringing the top left and top right edges in to meet along the center line as shown in DIG. 3.

3. **DIG. 3**

   Fold along the horizontal dotted line in DIG. 3 bringing the tip of the paper airplane down to the center of the base of the paper as shown in DIG. 4
• DIG. 4

Now fold along the diagonal dotted lines in DIG. 4 to bring the left top edge and right top edge in to meet at the center line as shown in DIG. 5

1. DIG. 5

Now fold the flap that points downwards up so that its tip touches the tip of the paper airplane at the front. Fold along the dotted line shown in DIG. 5 to do this. If the tips do not meet go back and alter the folding so that they do. This is very important. You should get the form (approximately) in DIG. 6

• DIG. 6

Now finally fold along the center line and dotted lines in DIG. 6 to give you the paper airplane as shown at the top of the page. Throw it hard overarm and it should fly very level and very straight for a long distance.
K-1

Prep: Read lesson and gather materials

Materials:
- Shoe Box
- Waxed Paper
- Masking Tape
- Newspaper
- Aluminum Foil
- Rubber Bands
- Ice Cubes
- Process Grids

Setting the Stage:
Ask students if they think they could keep an ice cube from melting. What are some ideas?

Explain the objective of the day: Students will make a contraption that will keep an ice cube from melting as fast as the ice cube that you will set out in front of the students. (This will be your control.)

Brainstorm some methods for building a shelter, and record on their Process Grids.

Objective (s):
Students will build a contraption that will keep their ice cube from melting as fast as a control ice cube sitting out in the classroom.

Instructor Notes:

Activity Instructions:
1. Have students work in groups of 3 or 4 to design their contraption. Have them place their ice cube inside. They will want to build fast so that their ice cube doesn’t continue melting!
2. After they build their contraptions, have them set their ice cubes inside and set them aside for 10-15 minutes. During that 10-15 minutes, ask each group to share how they made their contraption. What materials did they use? Why?
3. After you are done discussing, have students check their ice cube and compare it to the ice cube that was sitting out.
4. Discuss results. Which ice cube melted less? Which melted the most? What would they do next time?
DELIVERY SYSTEMS

WEEK 3
Deliver A Message

Next Generation Science Standards (NGSS):
K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
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-ETS1-3: 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.

**Objective (s):**
Students will deliver a message from one end of a table to the other (or between 2 desks).

**Instructor Notes:**

**Materials:**
- Pencil & Paper for writing a message
- Stuff to build a message delivery system: string, scissors, straws, water bottles, masking tape, rubber bands, etc.
- Process Grid

**Setting the Stage:**
Ask students: When you’re stranded on a deserted island, you can’t use a telephone or e-mail to communicate to others across the island. So how would you get a message to a friend on the other side of your island?

Explain the objective of the day: students will build a way to deliver a message from one side of the table (island) to the other. (Without throwing it or using their own feet to deliver it!)

Brainstorm ideas of what a delivery system might look like. Have them add their ideas to their Process Grid.

**Activity Instructions:**
1. Have students in teams of three. Each team can write a secret message to another team.
2. After they write their message, have them begin working on their delivery system. As they work, ask them questions about their plan. If something doesn’t work, ask them what they could do to redesign it. You may have to give a few suggestions to get them started. It could be as simple as rolling the message in a bottle across the table or folding it into an airplane to fly through the air, or a catapult. (Don’t give any hints unless there are some students really struggling and frustrated.)
3. If students succeed quickly, place “obstacles” in the way for more of a challenge.
4. At the end of the lesson, discuss what worked and what didn’t work. Add their results and what they learned to their Process Grid.

**Prep:**
Read lesson and gather materials

**Materials:**
- Pencil & Paper for writing a message
- Stuff to build a message delivery system: string, scissors, straws, water bottles, masking tape, rubber bands, etc.
- Process Grid
**Unit 1: Engineer Design It**

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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.

**K-5 30 Minutes**

**Prep:** Read lesson and gather materials

**Materials:**
- Aluminum foil (1 sq. foot for each pair of students, extra foil to redesign
- 100 pennies
- Bucket or tub of water
- Process Grid

**Setting the Stage:**

**Ask** students to think about different boats that they have seen. What shape did they have? What were they made out of?

**Explain** objective for the day: students will design a boat and test the number of pennies it can hold before it sinks.

**Brainstorm** ideas for building a boat, and have students add their ideas to their Process Grid.

**Objective (s):**
Students will construct a boat out of aluminum foil that can hold the most pennies.

**Instructor Notes:**

**Activity Instructions:**

1. Give students each one square foot sheet of aluminum foil. They can cut it, fold it, staple it, do whatever they want to design their boat.

2. When students have built their boat, let them test it and see how many pennies they can place in it without it sinking. Have them record their results on their Process Grid. When they know how many pennies their boat can hold, have them go back and redesign their boat to make it hold more pennies.

3. Re-test boats, and record the new results.

4. As a whole group, reflect on the results. How many pennies could the boat hold? How did they re-design their boat? Did the re-design work? Why or why not? Have students add what they learned to their Process Grids.
Sink the Ship

WEEK 5

Setting the Stage:

Ask students what kinds of things float on water and what kinds of things sink. What did they learn last week about what makes a boat float?

Explain today’s objective: Students will make a boat out of clay that can float. Then they need to figure out how to make it sink.

Brainstorm ideas for how they can design their boats. What will make it float? What will make it sink? Have them record their ideas (sketches) on their Process Grid.

Activity Instructions:

1. In groups of 3-4, have students design their boats using the clay. As they design, ask them questions about how they are deciding what to build.
2. Fill the bucket with water. Once students have designed their floating boats, have them test them to make sure they float.
3. Once they prove their boat can float, have them modify the design or add things to their boat to make it sink. They can add the small rocks or straws, or anything else you have on hand.
4. Have them re-test their boats to prove they can sink. Add results to their Process Grid.
5. As a whole group, discuss their designs. What did they do to make the boat sink? Can they think of any reason why someone would want to sink a boat? (You can tell them that when boats get too old to use anymore, the navy will sink them on purpose so that plants and animals can live and grow on it. It is called an artificial reef).

Objective(s):

Students will design a boat that floats and then find a way to make their boat sink to the bottom.

Instructor Notes:

Next Generation Science Standards (NGSS):

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K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

### Objective(s):
Students will create a way to move their bouncy ball from one table to the next table (3 feet apart).

### Instructor Notes:

**Activity Instructions:**

1. Divide students into groups of 3-4, and set each group up with two desks 3 feet apart. Give them their materials, and let them start designing and testing their models.

2. As they design, go around and ask students what is working and what isn’t working. If students succeed quickly, increase the distance between the desks and have them design again.

3. At the end of the class, discuss results as a whole group. Have groups share what they did, and explain what different designs they tried. What worked the best? What didn’t work? Record their results on their Process Grids.
K-1

ROLLING TUBES

Unit 1: Engineer Design It

Next Generation Science Standards (NGSS):

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K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

30 Minutes

Prep: Read lesson and gather materials

<table>
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<th>Materials:</th>
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<tbody>
<tr>
<td>• 20 Pieces of Copy Paper</td>
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<td>• Tape</td>
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<tr>
<td>• 20 Pieces of Construction Paper</td>
</tr>
<tr>
<td>• Cardboard Toilet Paper Tube</td>
</tr>
<tr>
<td>• 20 Pieces of Cardstock</td>
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<tr>
<td>• Straws</td>
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Setting the Stage:

Give students a toilet paper tube and a straw.

Ask them if they can make it roll from one side of the table to the other.

Explain today's objective: To make a paper tube that can roll faster than the toilet paper tube.

Show students the materials and have students share their ideas for how to make their own paper tube that rolls faster. (Bigger, smaller, longer, shorter.) Have them add their ideas to their Process Grid (sketches if they can't write).

Objective(s):

Students will make a paper tube that rolls the fastest powered by the students blowing on it through a straw.

Instructor Notes:

Activity Instructions:

1. Hand out materials and let students experiment to make their own tubes. When students get their tube made, have them have a race with a partner. (One blows on student made tube and the other blows on toilet paper tube.)

2. Ask them if they can change their design and make it go even faster. Have them record their results on their Process Grid.

3. When everyone has a “fast” tube, let them have a “roll off” against each other.

4. At the end of the lesson, discuss which tube went the fastest and why they think it did. Which wasn’t as fast? Why not? Add what they learned to their Process Grid.
**Unit 1: Engineer Design It**

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**Marshmallow Tower**

**WEEK 8**

**Materials:**
- Process Grid
- 2 Bags of large Marshmallows for each group

**Setting the Stage:**

**Ask** students if they have ever seen a really high tower. What did it look like? What did the base look like? What kept it strong?

**Explain** today's objective: Students will build the tallest tower they can with marshmallows.

**Brainstorm** ideas of how they might build the base of their tower to make it strong. Have them add their ideas to their Process Chart (sketches if they can't draw).

**Objective (s):**
Students will build a tower as high as possible without it falling down.

**Instructor Notes:**

**Activity Instructions:**
1. In groups of 3-4, let students begin building their towers. If their tower falls down, ask them how they could change the base to make it stronger. Have them record their results on their Process Grid.

2. If they manage to use up all their marshmallows and their tower is still standing, ask them if they could use the same number of marshmallows, but make a taller tower. How could they change their design to do that?

3. When done, use the idea that worked best and try it using all of the marshmallows to build the very biggest tower possible.

4. At the end of the class, discuss what worked and what didn't. What did the tallest tower look like? Add what they learned to their Process Grid.
Next Generation Science Standards (NGSS):

K-2-ETS1-1: Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

K-2-ETS1-2: Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Objective(s):
Students will make a bridge in between two stacks of books that are 6 inches apart by using 1 piece of paper that supports 50 pennies.

Instructor Notes:

Activity Instructions:

1. Have students work in groups to build their bridges. Remind them they can only use one sheet of paper! (Give them 3 sheets so that they can re-design).

2. Have them test their bridges with the pennies. If their first idea doesn’t work, ask them how they can change their paper to make it stronger. If their design works, ask them to make a bridge that is 8 or 10 inches long. Have them record their results on their Process Grid.

3. At the end of the lesson, discuss the results. What worked and what didn’t work? How did they re-design their bridges? Record what they learned on their Process Grid.