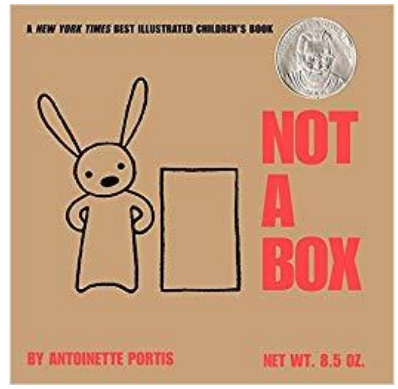
Contents

THINK OUTSIDE OF THE BOX (**Teacher Edition**)

Submitted by: Angell-Fall 2018



Grade Level: 2nd

Literacy Connection:

- *Not a Box by Antoinette Portis*

STEM Content Standards:

Science:

- 2-PS1-2 Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose. *

Technology and Engineering:

Engineering, Technology, and Applications of Science

- 4-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.

Standards for Technological Literacy

- Standard 9: Students will develop an understanding of engineering design.
  - A. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
  - B. When designing an object, it is important to be creative and consider all ideas.
  - C. Models are used to communicate and test design ideas and processes.
  - D. Sketches should be drawn.

Math:

- AR.Math.Content.2.NBT.A.2 –
  - A. Count within 1000

Big Ideas:

- The engineering design process can help people solve common problems.
- Students are able to count their materials and measure correctly.
- Materials have different properties to them. (waterproof, buoyant)

Scenario:

Humans are always using boats to transport goods from one place to another. Materials to make boats can be expensive. Engineers need to think about the materials being used and if they will float in water. Look through the materials provided and come up with different options as to what would make the strongest and least expensive boat to transport your goods (Marbles).

Essential Question:

How can you build a “boat” out of a box that can float in water?

Challenge:

- Design and build a boat that can float in water with weight being added to it
- Make sure to design the boat to carry weight inside of it.
- Complete each step of the STEM design journal
- The final boat must meet the limitations below

Limitations:

- The boat must float
- Teams have to place objects in carefully
- The box boat must be designed using only the materials provided below
- The box boat must be presented to the other teams when it is complete
- The box boat must be designed to hold as much weight as possible

Materials:

The materials available to construct the boat are below. The teacher is free to add additional materials or substitute materials as needed.

1 – 50 cm length duct tape	Marbles	1-- Sponge
1—30cm aluminum foil	3- Tongue depressors	3- Pipe cleaners
1—cardboard	Make-do	6 - Plastic drinking straws

Tools:

Each engineering design team will be able to use measuring tools, hot glue, and scissors.

Results (provide these items to the teacher for assessment)**:**

- Completed STEM design journal
- Presentation of completed boat
- Amount of marbles able to fit in the boat.

Content Information:

Discuss the following content information before assigning the engineering design teams the task of constructing a floating box.

- At the start of the investigation, allow students to discover the materials and their properties. At this point, students will make observations about which materials would be best to construct the boat.
- Share with students that different materials have different properties. Some materials are waterproof, and others aren't. Have students experiment with some materials in the water.
- Explain the difference between volume and density.
  - Show an example, in water, of a marble (sinking) and a straw (floating)
- Explain what "make-do's" are and how they work to connect cardboard.
- The engineering process will be used throughout the investigation.
  - Define the problem, Brainstorm solutions, create your solution, test your solution, evaluate your solution, share your findings.
- Show the videos below
- Students will need to figure out the mass of the marbles. Show how you can calculate the mass of one object and multiply by the total number of objects to find the total mass.
- Students may not realize that cardboard is not waterproof—let them figure that out.

- Introduce the following vocabulary words associated with this unit of study:
  - Density: How much space an object or substance takes up in relation to the amount of matter in that object or substance (its mass)
  - Buoyancy: The ability of objects to float in water or air
  - Volume: the amount of space that a substance or object occupies
  - Leakage: the accidental escape of a fluid through a hole or a crack.

Video:

Buoyancy

https://www.youtube.com/watch?v=nMlXU97E-uQ

Density

https://www.youtube.com/watch?v=dcQR6vV1Sqo

Testing:

After each team has completed the task of building their box boat, they will be asked to create a short presentation about why they chose the materials that they did. To test the design, the whole class will be gathered around the tub of water and the students will put the marbles into their boat. The team with the largest value of marbles will win. When testing, make sure students aren't touching their boat. Prior to testing their boat, students will be asked to weigh a single marble and then calculate the total mass after all of the marbles are placed in.

Teacher Evaluation: Think Outside of the Box

A teacher assessment rubric is provided below. You could also provide students with scores for their completed box boat, the amount of beans it holds, their completed STEM design journals, and their design presentations.

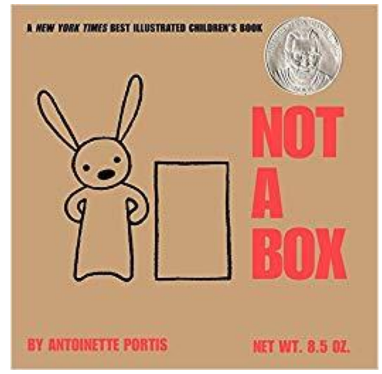
Name: Engineering Design Team Member Names:

Box boat was submitted along with completed journal	/10
Box boat demonstrated creative, thoughtful, and intentional use of materials to carry out design	/20
Team clearly and effectively presented their box boat to others in the class	/20
Box boat held additional weight	/20
Box boat was thoughtfully designed	/10
It was evident that the team followed the design process to create their box boat	/20
Total	**/100**
Additional Comments:	

Title: THINK OUTSIDE OF THE BOX (**Student Edition**)

Grade Level: 2nd

Literacy Connection: *Not A Box by Antoinette Portis*



Big Ideas:

- The engineering design process can help people solve common problems.
- Students are able to count their materials and measure correctly.
- Materials have different properties to them. (waterproof, buoyant)

Scenario: Humans are always using boats to transport goods from one place to another. Materials to make boats can be very expensive. Your task for the day is going to be to look through the materials provided and come up with different options as to what would make the strongest and least expensive boat to transport your goods (marbles). Remember the properties of the materials provided to come up with the best possible model. In order to figure out how much your boat can hold, you will need to find out the mass of a single marble. Once your boat has been tested, you will calculate the total mass of the marbles inside of your boat.

Essential Question:

How can you build a "boat" out of a box that can float in water?

Challenge:

- Design and build a boat that can float in water with weight being added to it
- Make sure to design the boat to carry weight inside of it.
- Complete each step of the STEM design journal
- Find the total mass inside of the boat (marbles).
- The final boat must meet the limitations below

Limitations:

- The boat must float
- Teams have to place objects in the boat carefully
- The box boat must be designed using only the materials provided below
- The box boat must be presented to the other teams when it is complete
- The box boat must be designed to hold as much weight as possible

Materials:

The materials available to construct the boat are below.

1 – 50 cm length duct tape	Marbles	1- Sponge

1—30cm aluminum foil	3- Tongue depressors	3- Pipe cleaners
1—cardboard	Make-do	6 - Plastic drinking straws

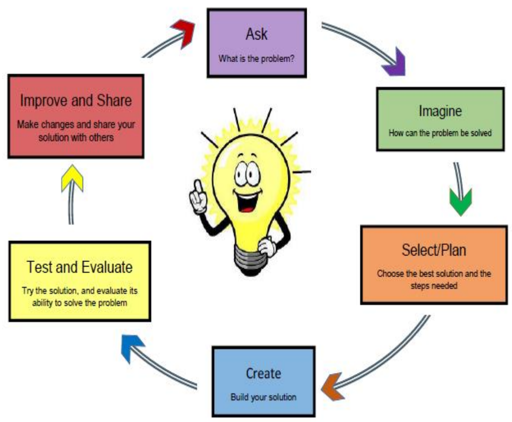
Tools:

Each engineering design team will be able to use measuring tools, hot glue, and scissors.

Results (provide these items to the teacher for assessment)**:**

- Completed STEM design journal
- Presentation of completed box boat
- Amount of marbles your boat can hold
- Calculate the mass of the total number of marbles

STEM Design Journal



Name:

Engineering Design Team Names:

What problem are you solving?

IMAGINE how you can solve this problem—Draw two or three sketches of ideas for your box boat

SELECT the best box boat idea and draw it here

CREATE your solution—What materials will you use to build your box boat?

Test Your Box Design

REFLECTION: Answer the following questions:

What causes an object to float?

Does the weight of the boat effect its ability to float?

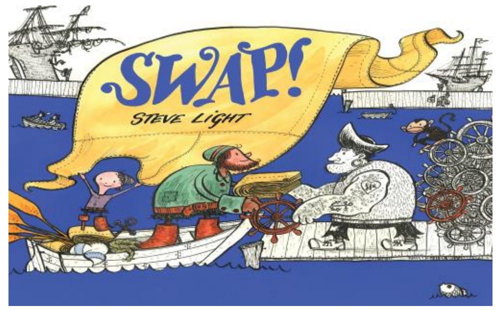
What is the amount of space an object takes up?

Describe density:

Why did your team select this design, instead of another?

(Teachers' Edition)

SWAP!
Submitted by: Suannah Clark



Grade Level: 2nd Grade

<u>STEM Content Standards:</u>

- Science- **2-PS1-2:** Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.
- Technology/Engineering- **Standard 9: Students will develop an understanding of engineering design.**
    - c. The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.
    - D. When designing an object, it is important to be creative and consider all ideas.
    - E. Models are used to communicate and test design ideas and processes.
- Mathematics- **AR. Math.Content.2.MD.C.8:** Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using $ and ¢ symbols appropriately

Big Ideas:

- Things are more buoyant depending on what they are composed of.
- Archimedes was the one that realized that when things float, the weight is displaced across the surface area of the water.

Essential Question: How can you best build a boat (while keeping buoyancy in mind) out of the given materials to hold the most money?

Scenario: It is now up to you and your group to help the characters in the book design their boat. They have all of their possible materials, all they need now is for you to put it together.

Vocabulary:

- **Archimedes' Principle-** states that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight of the fluid that the body displaces and acts in the upward direction at the center of mass of the displaced fluid.

- **Buoyancy-** the ability or tendency to float in water.
- **Currency-** a generally accepted form of money, including coins and paper notes, used as a medium of exchange for goods and services.
- **Density-** the amount of mass something has, in relation to its volume.
- **Engineering Design Loop-** a process or series of steps to follow when one is trying to solve a problem and come up with a solution for that problem.
- **Mass-** a measure of the amount of matter in an object.
- **Volume-** the amount of space that a substance or object occupies.

Challenge: Like the characters in the story, it is your job to build two boats out of the best materials you are given. Unlike the story, instead of trading to get what you need it is all given to you but the resources are limited. The only job of your boat is to make sure it can hold as much currency as possible without getting water in it and sinking. You will be given pennies, nickels, dimes, and quarters as your currency. It is your job to decide which coins you would like to use. After all the boats are built, you must test them to see how much they hold. After testing, you must decide which boat to use in the class competition. The winner will not be decided by how many coins it holds, but by the amount. The boat that holds the most money without sinking is the winner.

Tools, Materials, and Resources:

Materials:
- Aluminum Foil
- Popsicle Sticks
- Styrofoam
- Duct Tape

Resources:
- Hot Glue Gun
- Scissors
- Ruler

Teacher Video Resources:
https://www.youtube.com/watch?v=nMlXU97E-uQ
https://www.youtube.com/watch?v=05WkCPORlj4

https://easyscienceforkids.com/best-archimedes-principle-video-for-kids/

Content Information: Buoyancy is the ability of objects to float in water or air. Whether or not an object has buoyancy depends mostly on two factors: the amount of water an object displaces and the density of an object. A pebble is dense and displaces very little water, therefore it sinks. However, a basketball is not very dense and displaces more water, therefore it floats.
Buoyancy is a force that pushes up on objects, and the more surface area the object has for

the force to push up on, the greater chance it will float and the more weight it will hold. In addition, more water is displaced when the surface area of an object is large.
Archimedes' principle states that any object immersed in a fluid is acted upon by an upward, or buoyant, force equal to the weight of the fluid displaced by the object. When an object is dropped into water, some of that water is displaced. At the same time, buoyancy is pushing up on the object, which changes its weight. If the weight of the object is heavier than the amount of water it displaces, the object will sink. If the amount of water displaced is equal to the weight of the object, it will float.

Results: Once the students have finished building their boat, there will be tubs of water placed around the room for the preliminary testing of their boat. After they have chosen the boat they would like to use in the class competition, all students will come to the front of the room to test all of their boats to see which one could hold the most money. The teacher should have the students turn in their completed design journals and ask students if they can explain the design steps and buoyancy.

Limitations: The students cannot use more than 10 popsicle sticks, 5 blocks of styrofoam, 1 piece of duct tape (1 foot long), and 5 pieces of aluminum foil (5 inches x 5 inches).

Evaluation: The students at the end of this project will be asked about their design and they must be able to explain how they used the design process and give rationale behind choosing the materials to make their boat. The winner of the design competition will talk about their boat in front of the whole class. But for the other groups, the teacher should be walking around while the students are designing and building to question their process and gauge for understanding.

Teacher Evaluation Rubric:

Team Name:

Category:	0-3 Points (Unacceptable)	4-6 Points (Intermediate)	7-10 Points (Accomplished/ Superior)	Score:
All members of the team worked together efficiently and respectfully.				

Several options were sketched out before deciding on which model to build first.				
All team members were able to accurately explain what buoyancy was after end of project.				
Students were able to understand the different currency that was available to them and could explain how much they were worth.				

Total Points: /40

Comments:

STEM DESIGN JOURNAL

Name:

Team Name:

What problem you are trying to solve?

Draw three ideas for your boat.

Redraw the one you chose

What did you make it out of? Did it work? What didn't work?

How could you make it better?

RESULTS/REFLECTION WORKSHEET:

Testing Finished Boat: After you have built two boats out of the given materials, test them at one of the tubs around the room. When you have decided which boat you like best, come to the front of the classroom for the competition. REMEMBER the boat that holds the most money will win!

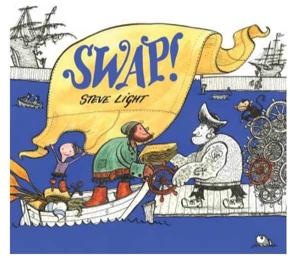
How many coins did your boat hold? How much money was it?

Did your boat hold as many coins as you thought it would? Why or why not?

Why did you choose the boat you did for the classroom competition.

In your own words, explain why things are buoyant (why do they float)?

An Introduction to Buoyancy and Design



Title: *Swap!* by Steve Light

Names of Team Members:

Design Challenge: You and your group need to build a boat that will hold the most money. You must make two boats out of the materials given to you, and then decide which is the better boat to compete in a class wide competition. The team with the boat that stays **buoyant** and completely water-free while holding the most money will win.

Limitations: You cannot use more than 10 popsicle sticks, 5 blocks of Styrofoam, 1 piece of duct tape (1 foot long), and 5 pieces of aluminum foil (5 inches x 5 inches).

Available Tools and Materials:

Materials:
- Aluminum Foil
- Popsicle Sticks
- Styrofoam
- Duct Tape

Resources:

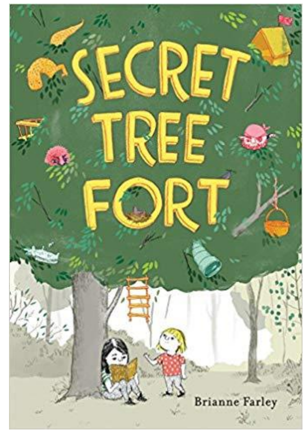
- Hot Glue Gun
- Scissors
- Ruler

Vocabulary:

- **Buoyancy-** the ability or tendency to float in water.
- **Currency-** a generally accepted form of money, including coins and paper notes, used as a medium of exchange for goods and services.
- **Engineering Design Loop-** a process or series of steps to follow when one is trying to solve a problem and come up with a solution for that problem.

Deliverables: Every team should be prepared to give their reasoning for choosing the materials they did in front of the class. You should also be able to explain the engineering design loop and what you would change if you could design the model again.

STEM CHALLENGE (Teacher's edition)



THE SECRET TREE FORT

Submitted by: Makayla Terry

Grade level: 4th

Literacy Connection:
Secret Tree Fort by Brianne Farley

STEM Content Standards:

<u>Science standard:</u>

4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide.

<u>Technology and Engineering:</u>

4-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.

<u>Standards for Technological Literacy</u>

- Standard 11: Students will develop abilities to apply the design process.
  E. The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.

<u>Mathematics:</u>

AR.Math.Content.4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money including the ability to make change; including problems involving simple *fractions* or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit

Big Ideas:

- A pulley system works because it changes the direction of the force applied, therefore making it easier to lift.
- Gravity is the force that pulls everything to the ground.
- The engineering design process is an excellent way to solve everyday problems.

Scenario:

The girls have started designing their secret tree fort but they need YOUR help! The basket for snacks and other emergencies is the only thing left to make, and it's up to your team to design it! Your team will need to build a structure with a pulley system that will hold eight quarters using the materials below, keeping in mind your budget of $5.00 for this project.

Essential Question:

How can you build a system that will overcome gravity and raise a weighted-down basket in the air?

Challenge:

Build a structure with a pulley system using only the available materials that will hold the required amount of weight.

Limitations:

- The teams will only have $5.00 to purchase materials with.
- The structure must be sound (stand on its own)
- Teams should only pull the string when demonstrating
- The system must be designed to hold as much weight as possible
- The structure and pulley system must be demonstrated for the other teams when it is complete

Materials:

The materials available to design the pulley system with a bucket are below. The teacher can add or substitute as desired.

Spool - $2.30	String - $0.62	Half an Easter Egg (basket) - $0.37	(10) Craft sticks - $0.19
Straws - $1.17	Push pins - $0.73	Pencils - $0.86	Paperclips - $1.92

Tools:

Each team will be able to use scissors, measuring tools, and hot glue

Results:

- Presentation of completed pulley system
- Weight achieved during test of system
- Completed STEM design journal

Content Information:

Discuss the following content before assigning the groups the task of building a pulley system.

- Discuss the design loop process and encourage them to use it for help for this project.
- Discuss other innovations similar to the pulley system
- Practice making change
- Discuss that a pulley works because it changes the direction of the pull or force applied, therefore making it easier to raise.

Testing:

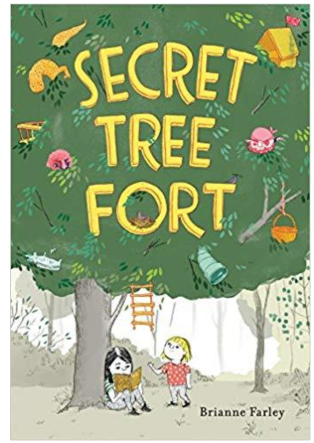
After the teams have completed their designs, have them be prepared to share their designs with the class. Ask them to explain their design and present the unique features. Test their systems with the appropriate amount of weight in their basket and have them demonstrate their pulley system by pulling the string. If modifications need to be made, encourage them to do so. See which group can hold the most quarters in their basket.

Teacher Evaluation: The Secret Tree Fort

Engineering Design Team Member Names:

Pulley system was submitted along with completed journal	/10
Pulley system demonstrated creative, thoughtful, and intentional use of materials to carry out design	/20
Team clearly and effectively presented their pulley system to others in the class	/20
Pulley system achieved weight goal	/20
Pulley system was easy to operate	/10
It was evident that the team followed the design process to create their pulley system	/20
Total	**/100**
Additional Comments:	

STEM CHALLENGE



Title: THE SECRET TREE FORT (**Student Edition)**

Grade level: 4th

Literacy Connection: *Secret Tree Fort* by Brianne Farley

Big Ideas:

- A pulley system works because it changes the direction of the force applied, therefore making it easier to lift.
- Gravity is the force that pulls everything to the ground.
- The engineering design process is an excellent way to solve everyday problems

Scenario:

The girls have started designing their secret tree fort but they need YOUR help! The basket for snacks and other emergencies is the only thing left to make, and it's up to your team to design it! Your team will need to build a structure with a pulley system that will hold eight quarters using the materials below, keeping in mind your budget of $5.00 for this project.

Essential Question:

How can you build a system that will overcome gravity and raise a weighted-down basket in the air?

Challenge:

- Build a structure with a pulley system using only the available materials that will hold the required amount of weight.
- Complete the STEM design journal.

Limitations:

- The teams will only have $5.00 to purchase materials with.
- The structure must be sound (stand on its own)
- Teams should only pull the string when demonstrating
- The system must be designed to hold as much weight as possible
- The structure and pulley system must be demonstrated for the other teams when it is complete

Materials:

Spool - $2.30	String - $0.62	Half an Easter Egg (basket) - $0.37	Craft sticks - $0.19
Straws - $1.17	Push pins - $0.73	Pencils - $0.86	Paperclips - $1.92

Tools:

Each team will be able to use scissors, measuring tools, and hot glue

Results (provide these items to the teacher for assessment):

- Presentation of completed pulley system
- Weight achieved during test of system
- Completed STEM design journal

STEM DESIGN JOURNAL

Name:

Engineering Design Team Names

What problem are you solving?

THINK of how you can build this structure --- draw 3 sketches.

Plan your final idea, pick the best one and draw it here.

BUILD your solution – what materials are you using

TEST your solution with the appropriate weight

Did you solve the problem?

FIX & SHARE: Can you improve your solution?

MY GOLDEN BRIDGE

(Teacher Edition)

Submited by: Chloie Quinn

Grade Level: 3rd

Literacy: *Pop's Bridge* by Eve Bunting

STEM Content Standards:

Science:

PSI3-ETS1-1 Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

Technology and Engineering:

3-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.

Mathematics:

Measurement and Data: Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects

> AR.Math.Content.3.MD.A.2: Measure and estimate liquid volumes and masses of objects using standard units such as: grams (g), kilograms (kg), liters (l), gallons (gal), quarts (qt), pints (pt), and cups (c)

Big Ideas:

- Bridges are structures that provide a purpose of providing passage over an obstacle or connecting two far- off points.
- Construction of bridges requires surpluses of tools, materials, and resources, including labor.
- Accurate measurements for construction of bridges.
- Use of the design loop

Essential Question: How can you construct a bridge out of limited resources that can withstand the weight of a toy dump truck and quarters?

Scenario: Using the engineering design loop and process along with the information you know about bridges, can you build a bridge out of limited materials that can withstand the weight of a toy dump truck and quarters?

Content Information:

- History:

- Bridges date all the way back to prehistoric ancestors.
- Wood was the main material that bridges were made of in ancient times.
- The first iron bridge was made in 1779 and was the first large structure to be constructed from iron.
- Steel and iron bridges became popular and now concrete is used to build them
- Purpose
- Bridges are designed to carry their own load, traffic, and to resist natural forces, such as earthquakes.

Introducing the Design Challenge: After introducing the above content information and reading *Pop's Bridge* to the class, explain the specifics of the design challenge:

- Review the design loop process with the students and encourage its use during this project.
- Choose the students design teams (2-3 students per team)
- Give each student the design handout and journal reflection sheet, which should be completed as they are constructing.
- Discuss the parameters for the project, including the tools and materials, as well as the limitations.
- Encourage the use of the design loop throughout the whole process of constructing the bridge.
- Once the hour for construction is up, place the bridge between the two desks 18 inches apart and roll the dump truck to the middle of the bridge. Start placing quarters in the truck until the bridge collapse.
- Reward the team whose bridge held the most quarters with a prize.
- Collect the student edition handout and the design journal reflection

Tools, Materials, Resources: 2 straws, 2 Popsicle sticks, 1 (8.5in x11in) piece of paper, 1 (30cm) piece of duct tape, 1 plastic fork, 1 (6in x 6in) piece of aluminum foil, 3 paper clips, 2 rubber bands, 1 (45cm) length of string- All teams will be provided with scissors and hot glue.

Results: The students will need to deliver the completed bridge, along with the student edition handout and the design journal reflection.

Limitations: The bridge must be able to reach across 18 inches of open space, however it can be longer and however wide. They can only use the resources listed and the dump truck with quarters must be placed on top of the bridge when being tested. Students can test their bridge as much as they like before the final test, however they run the risk of the bridge breaking before the final test.

Evaluation: The students will have a rubric as an evaluation, along with a peer review to ensure that each member of the group participated.

Teacher Evaluation Rubric:

Points	**Criteria**	**Standard**
(0-15) points	Students demonstrated knowledge of bridges.	Students used their knowledge of bridges to construct one to hold the weight of three objects.
(0-15) points	Use of limited resources	Students were able to complete assignment using limited materials and tools.
(0-15) points	Completion of Handouts	Students completed the handouts and journals.
(0-20) points	Team Participation	Students worked cooperatively and effectively as a team.

My Golden Bridge

(Student Edition)

Engineering Design Team Members: ____

Design Challenge: Working with your assigned design team, you are to construct a bridge that can withstand the weight of a toy dump truck holding quarters. The bridge must reach between two desks that are separated 18 inches apart. You will have an hour to complete the design and once it is ready for testing, the bridge will be placed on the two desks. The dump truck will be rolled onto the middle of the bridge and quarters will be place in the truck until it collapses. The team whose bridge holds the most quarters before collapsing wins.

Limitations: In order to complete this design challenge, you must follow the following rules and adhere to the design parameters:

1. Teams will be allowed 1 hour to complete the construction of their bridge.
2. Teams must only use the tools and materials listed below.
3. The bridge must extend for 18 inches over an open space and withhold the weight of a toy dump truck with quarters. They can be longer than 18 inches and however wide.
4. The teams are allowed to test their bridge as much as they would like before the final test, however this runs the risk of the bridge breaking before the final test.
5. The bridge that holds the most quarters before collapsing wins.
6. Teams must complete the Design Journal Reflection handout individually and turn it in.

Tools/ Materials:

2 plastic drinking straws	1 plastic fork	2 rubber bands
2 Popsicle sticks	1 (6in x 6in) aluminum foil	1 (45cm) piece of string
1 (30cm) piece of duct tape	Hot glue	
1 (8.5in x 11in) paper	3 paper clips	

Note: Scissors and hot glue will be provided to all teams.

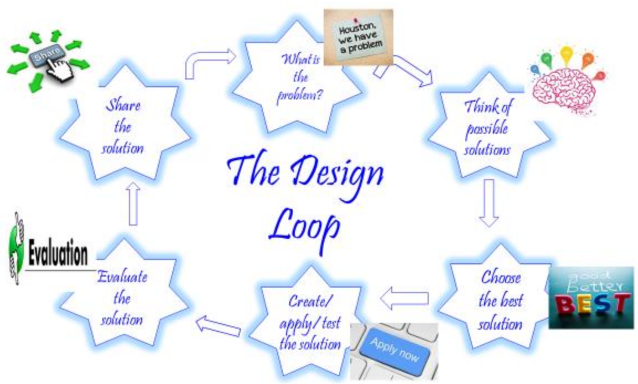
Deliverables: Each team should submit the completed bridge construction, the student edition handout sheet with the team member names along with the design journal reflection.

Design Journal Reflection

Name:______________________________

Team Members: ____

Directions: Complete the following questions and reflections individually as you complete the construction of your bridge. Remember to refer back to the design loop.



What is the PROBLEM?

____

BRAINSTORM: Draw or explain different ideas for how to build your bridge.

____

____

____

CHOOSE: Select the best idea for your bridge. Explain how you will complete this and draw what you think it will look like.

____

What materials are you using?

____

____

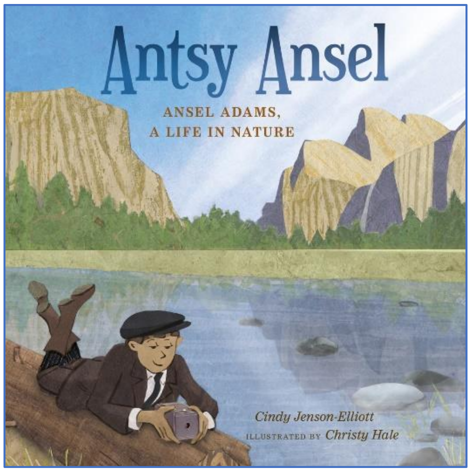
How long and wide is your bridge? ______________________________________

EVALUATE: Did the bridge work the way you wanted it to? What could you have done differently?

____

____

____



HOW WE SEE: INTRODUCING THE MECHANICS OF VISION

(Teacher's Edition)

Submitted by: Robyn Lane

Grade Level: 4

Literature: Antsy Ansel: Ansel Adams, A Life in Nature, by Cindy Jensen-Elliot

Supporting Resources:

- Bill Nye the Science Guy on The Eyeball (https://www.youtube.com/watch?v=cFVbLnXWn6A)
- Ansel Adams: Photographs in Yosemite (https://www.youtube.com/watch?v=322UnYVlNyU)
- Eye vs. Camera (https://www.youtube.com/watch?v=CL61MbyYsd4)

Other Objects Required

- A fixed length pinhole camera like the one illustrated here (one per group) i(https://i.pinimg.com/originals/92/76/f2/9276f2221d2538df4ddc2313c126cccb.jpg)
- An adjustable pinhole camera such as this one (one per group) (https://www.youtube.com/watch?v=IdNoNTGNkW4&t=902s)
- An old film camera, if available, for reference.

STEM Content Standards

Physical Science

- 4-PS4-2: Develop a model to describe that light reflecting from objects and entering the eye allows objects to be seen.

Engineering, Technology, and Applications of Science

- 4-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.

Mathematics

- 4.NF.A1: Extend understanding of fraction equivalence and ordering
  - By using visual fraction models, explain why a fraction $\frac{a}{b}$ is equivalent to a fraction $(n\ x\ a)/(n\ x\ b)$ with attention to how the number and size of the parts differ even though the two fractions themselves are the same size

- Use this principle to recognize and generate equivalent fractions

Standards for Technological Literacy

- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

D. The process of experimentation, which is common in science, can also be used to solve technological problems.

Big Ideas

1. The reflection of light off objects is how we see (and how we photograph) objects.
2. Cameras (technology) mimic the way an eye works.
3. Because light travels in straight lines, when it passes through a small opening (like your pupil or a camera's aperture), the image is upside down and reversed.
4. The size of the opening determines how much light is allowed in (smaller openings for bright light, larger openings for dimmer light).
5. The focal length of a camera is a fraction expressed as the distance from the pinhole to the imaging screen divided by the diameter of the pinhole.
6. When an object is in focus on the imaging screen, the ratio (I:F) of the image height (I) to the distance from the pinhole to the imaging screen (F) is equivalent to the ratio (O:D) of the object height (O) to the distance from the object to the pinhole (D). Because geometry…

Essential Question

Using what you know about light and vision and based on your observations of the pinhole cameras that we used during class, how can you build a pinhole camera that improves the image size, brightness, and focus for better viewing?

Scenario

Your class is following in the footsteps of Ansel Adams to become photographers. In fact, you'll be having a photography competition to see who can produce the best image using a pinhole camera that you've built!

Content

Photography is literally "drawing with light" (from the Greek words "photos" – meaning light -- and "graphe" – meaning draw). Without light, we wouldn't have photography…and we couldn't see. Therefore, the properties of light impact how and what we see. Light travels in straight lines, and objects become "visible" when light is reflected off them and enters our eyes. The technology we use for photography, from a simple pinhole camera to a complex DSLR, captures light in a way very similar to the human eye. Thus, a camera's structure can serve as a model for the structures of a human eye.

Teacher Tips

- This activity may be broken down into discrete components and covered in several class periods. For example, students may conduct evaluations of the fixed and adjustable pinhole cameras provided during one class period to identify problems and brainstorm solutions. A second class period could be devoted to construction of the model, and the final tests could be conducted in a third class period.

After showing videos about the eye, it may be fun to have students test the reaction of the pupil to light with small flashlights to reinforce the idea that pupils (and by extension, camera apertures) adjust to let in more or less light depending on light conditions.

Introducing the Design Challenge

After introducing the content above to your students:

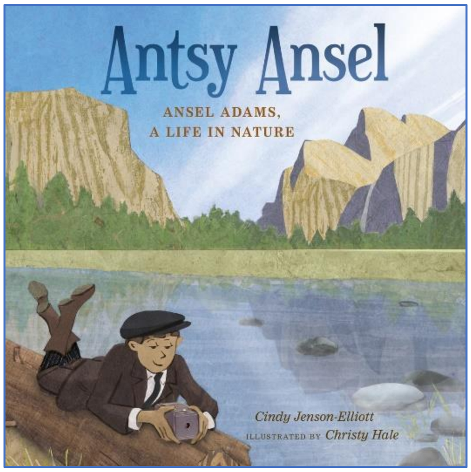
- Revisit the text to point out how Ansel Adams was entranced by the light at Yosemite, and that light was key to his photographs.
- Show the video Ansel Adams: Photographs in Yosemite and ask students to imagine what the quality of light is in the photographs. (Is it bright and sunny? Overcast? Can they make guesses about the time of day or the time of year from the light? Ask them to describe what it is in the photographs that gives them clues about the light.)
- Tell the students that they are going to be presented with a design challenge involving photography. Discuss the engineering design process and the role it plays in solving the problem.
- Divide students into teams of 2-3 students. Tell them they will be evaluated on how well they solve the problem and how well they work as a team.
- Provide each team with a fixed pinhole camera and an adjustable pinhole camera. Demonstrate how they work, and give students time to play with them. They should be surprised to find that the images produced are inverted and reversed.
- Show the videos "Bill Nye the Science Guy: On the Eyeball" and "Eye vs. Camera" to start talking about how light works and why the images are inverted/reversed.
- Ask the teams to assess the pinhole cameras provided: how well do they work? What would make them better? Have the students test them under different conditions and make notes about the results (bright light? Lights off? Single light source behind the camera? Single light source in front of the camera? With a cloth over your head (like you see in old photos)?
- Have teams research and brainstorm ideas to improve the camera.
- Provide each team with the student edition of the design challenge and briefly discuss the parameters for the activity. (Time, materials, testing, evaluation, etc.)
- As the teams work, move between groups to make sure that they are using the engineering design process.
- After each team has completed their camera, conduct impartial tests! Each student will be asked to rate the other cameras (but not their own) on the basis of image size, brightness, and sharpness of focus using a Likert scale for each measure.
- Number each camera. Have each student test it by observing a brightly colored, easily discernible object set at a fixed, marked distance from the object. Each student will then

rate the camera using the provided rating sheet. The camera that has the highest cumulative score will be the winner.

- After each student has tested the camera and before moving it, the team who built the camera will measure the distance of the imaging screen from the pinhole and note it in their design journal.
- Teams should complete their handouts and journals and submit them, along with their camera, for assessment.

Rubric

How We See: Introducing the Mechanics of Vision					
	Beginning 0-5 pts	**Intermediate** 6-10 pts	**Competent** 11-15 pts	**Proficient** 16-20 pts	**Total Points**
Teamwork: Students worked together effectively to complete the project.					
Use of Engineering Design Process: Team demonstrated thoughtful use of the design process throughout the project.					
Performance: Project performed the intended function and met all the design parameters.					
Completeness: All elements of the project were turned in, on time, and were fully completed to an acceptable level of detail.					
Knowledge: Students displayed comprehension of the important concepts.					



How We See: Introducing the Mechanics of Vision

(Student's Edition)

The technology we use for photography, from a simple pinhole camera to a complex DSLR, captures light in a way very similar to the human eye. A camera's structure can serve as a model for the structures of a human eye. The differences in the structures and mechanics of a camera and an eye are a result of the different properties of the materials that make up each component.

Design Challenge

Your team is tasked with designing a "better" pinhole camera, based on your observations of the two models provided for you. You will evaluate the two models to identify problems that could be improved, and using the engineering design process, solve some or all of those problems in your design. At a minimum, your design must: 1) have a viewing screen that is larger than 1" x 1"; 2) be able to be adjusted for focus; and 3) allow enough light in to create an image that is easily viewed. You may identify other problems and address them in your solution as well. At the end of the challenge, all cameras will be rated by students on image size, brightness, and sharpness using a rating sheet to be provided. (Note: teams will not rate their own cameras.) The camera with the highest cumulative score wins the design challenge.

Limitations

Teams must adhere to the following design parameters:

1. Teams will have 20 minutes to test the two pinhole cameras provided, make notes in their design journal to identify problems, and brainstorm ideas.
2. Teams will have 45 minutes to complete the design journal and build a working prototype of their camera design that solves the design challenge.
3. Teams must use only the materials and tools listed in this design brief.

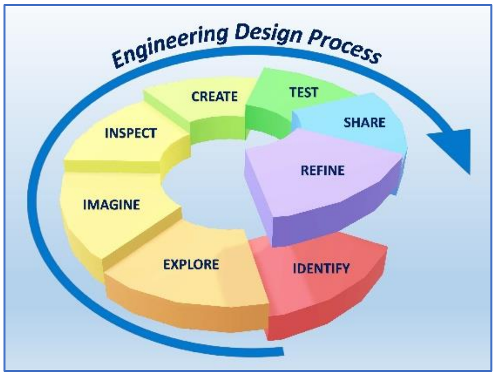
Tools and Materials

3 shoe boxes	1 pushpin	1 roll duct tape
3 sheets tracing paper	scissors	1 roll scotch tape
3 sheets precut aluminum foil	ruler	1 roll packing tape

Deliverables

- Completed pinhole camera

- Results/Reflection Handout
- Design Journal



<u>How We See: Introducing the Mechanics of Vision</u>

Design Journal

Student Name:

Engineering Design Team:

IDENTIFY the problems you discovered in the pinhole cameras you examined.

IMAGINE ways that you can solve these problems.

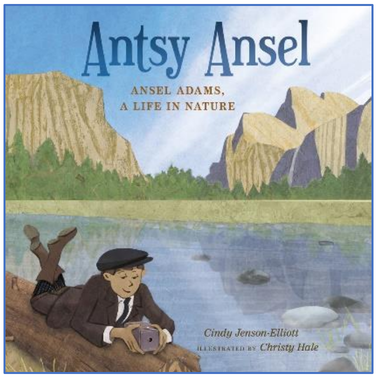
INSPECT your solutions and choose the best option(s). Make a sketch below.

CREATE your solution. What materials did you use?

TEST your camera. Did it meet the minimum standards of the challenge? Can you **REFINE** your solution?

What was the distance of your camera's imaging screen from the pinhole after testing? -

____



How We See: Introducing the Mechanics of Vision

Camera Rating Sheet

Student Name:

For each camera, rate its image size, brightness, and focus on a scale of 1-5, with 1 being worst and 5 being best.

Camera #1

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #2

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #3

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #4

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #5

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #6

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #7

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

Camera #8

Image Size	1	2	3	4	5
Image Brightness	1	2	3	4	5
Image Focus	1	2	3	4	5

A PLACE TO CALL HOME

Submitted by: Jobe

Grade Level: 3rd-4th grade

STEM Content Standards:

- **Science:**
  - 3-LS4-4. Make a claim about the merit of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change*.
    - Interdependence of Science, Engineering, and Technology: Knowledge of relevant scientific concepts and research findings is important in engineering.
- **Technology and Engineering**
  - ETS1.A: Defining Engineering Problems - A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions.
  - 3-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.
- **Math**
  - 3.MD.A.2
    - Measure and estimate liquid volumes and masses of objects using standard units such as: grams (g), kilograms (kg), liters (l), gallons (gal), quarts (qt), pints (pt), and cups (c)
    - Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same unit

Big Ideas:

- How we interact with the environment has impacts that we may not intend.
- We share the earth with other organisms, so we must be aware of our actions.
- Design and engineering can help us determine ways to help solve those unintended results.

Content Information:

- **Science:**
  - Different types of ecosystems, different biomes, different types of animals.
  - Animals try to adapt to changing environment, but does not always happen.
  - Bird/animal habitats (various types of animal homes).
    - May provide books or information on where and how birds build their nests.
  - Seasons/weather patterns, how these affect what the animal needs.
- **Technology/Engineering**
  - Technology we create can have negative effects we often do not intend.

  - Technology can be useful in trying to fix those negative outcomes
  - Often times our ideas for technology come from what we see in nature
  - How woven materials can create a strong structure.
- **Mathematics:**
  - Weight: nests/homes must be able to sustain the weight of an animal.

Mini Lessons/Activities:
Listed below are some activities or discussion topics to review prior to completing the bird home challenge. This will help to introduce the ideas involved with this topic. This is simply to get students thinking about the topic while also providing some back ground knowledge.

1. Discuss different types of animals (birds, mammals, reptiles, fish, etc.) and the places they live (including biomes and the types of habitats they reside in). Discuss the differences in their habitats.
2. Ask students to think about what factors they think might affect what is needed to build a home. Perhaps discuss their own homes and what they need versus what an animal may need.
3. Include a discussion or video on bird nests specifically. Talk about different types of birds and their nests. Include birds in different climates.
4. Incorporate a lesson on weight. Give students the opportunity to explore different objects' weights on a scale. Provide different types of scales. Discuss different units of measurement.

Scenario:

  - You are a wildlife preserver, and your town is starting to grow. They are expanding their city into the neighboring forest which means trees are being taken down, and animal's homes are being removed. The trees are disappearing at a fast rate, so it is vital that we replace these nests since the birds won't have a chance to rebuild their homes immediately. It is your job to create nests for the local birds that can be reusable, withstand the weight of birds, is durable in all types of weather, and is safely tucked into the city

Essential Question:
How can we make a nest that is durable and can withstand the weight of a bird?

Challenge:
Students will work in pairs of 2-3 to build a nest that withstands the weight of a "bird." After completing the construction, we will put the stated weight into each nest to test the strength. Teams will then present their nests to the "city planner" about why their nests meet the other criteria for the city.

To test the nests, tape two rods across a gap in-between two desks. The nest should be placed in this gap, then the (8oz) weight should be placed in the nest. The same weight should be used for all tests. The nests that don't let the weight fall through passes.

Parameters or Constraints:

- The nest must:
  - Be constructed with the provided materials
  - Be able to hold 8 oz of weight

    - Be able to hold 2 birds at least
    - Give them 1 hour to complete construction

Tools, Materials, and Resources

- Scissors (only to use as a tool)
- Tooth picks
- String/Twine
- Ribbon
- Paper
- Strips of toilet paper
- Streamers
- Zip Ties

Deliverables

- Nest of some sort that holds 8 oz of weight

Evaluation

- Student design journal
- Student presentation of nest to "city planner"
- Teacher Rubric

Teacher Rubric

Student Name: ______________________________

- Student Participation:
    - Least 1 2 3 4 5 Most
    - Comments:

      ____

- Student displayed use of design model (design journal)
    - Least 1 2 3 4 5 Most
    - Comments:

      ____

- Student's nest met criteria
    - Least 1 2 3 4 5 Most
    - Comments:

      ____

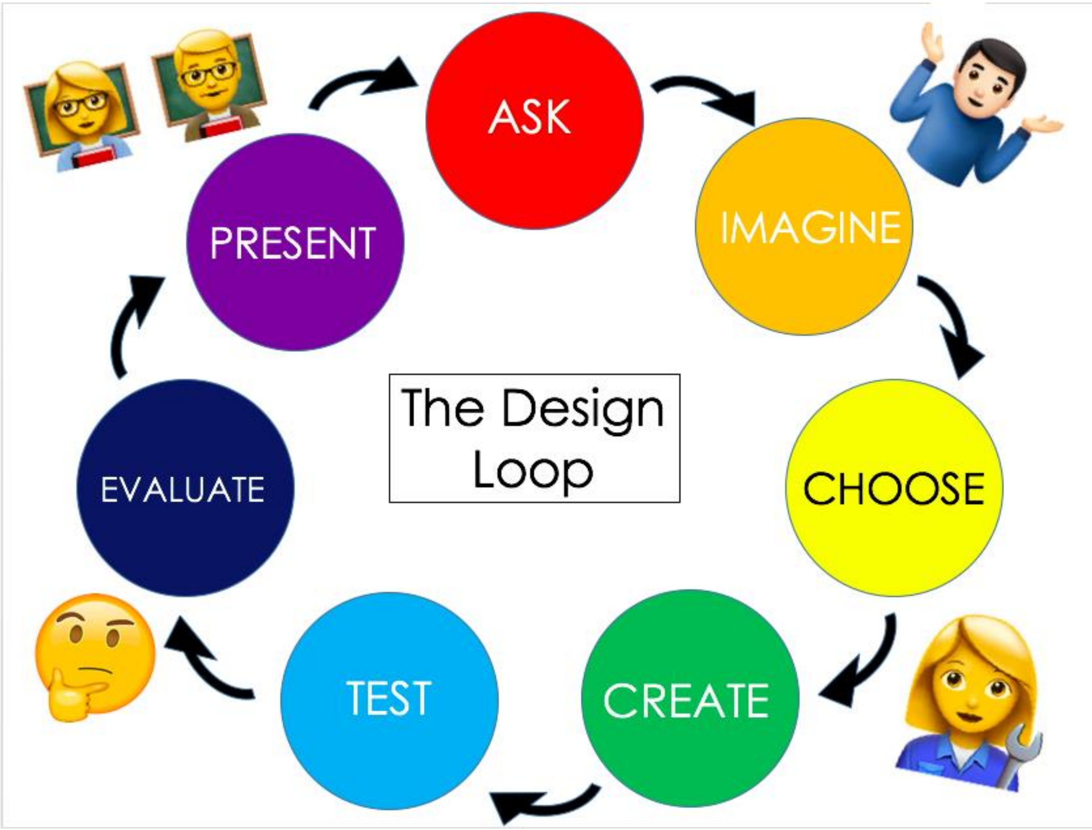
- Student shows understanding of overall concept/can rationalize work
  - Least 1 2 3 4 5 Most
  - Comments: ____

- Student worked collaboratively with team
  - Least 1 2 3 4 5 Most
  - Comments: ____

Total Score: ____/30 points
Comments:____
____

A Place to Call Home

How can we make a nest that is durable and can withstand the weight of a bird?



Home Needed!

You are a wildlife preserver, and your town is starting to grow. They are expanding their city into the neighboring forest which means trees are being taken down, and animal's homes are being removed. The trees are disappearing at a fast rate, so it is vital that we replace birds' nests since the birds won't have a chance to rebuild their homes immediately. It is your job to create nests for the local birds near the city.

- Your nest must:
    - Be constructed using materials from list below
    - Be able to support 8 ounces of weight
    - Be able to fit two small "birds"
    - Be constructed within 1 hour – time is running out for the birds!
- Materials:
    - Scissors (only to use as a tool)
    - Tooth picks
    - String/Twine
    - Ribbon

- Paper
- Strips of toilet paper
- Streamers
- Zip Ties

Design Journal

ASK: What is the Problem?

____
____
____

IMAGINE: How can this problem be solved?

____
____
____

PLAN: Draw ideas and list possible materials

Create and test your ideas!

Does your design hold 8 ounces of weight and fit two “birds.” If not, what are some changes you may need to make?

____
____
____

PRESENT

Once you have a design selected and tested, you will present your nest for the birds to the city planner. You will explain how your nest meets the needs of the birds and the city, and why the city planner should choose your nest to save the birds' homes! Write some of your key selling points!

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STEM CHALLENGE

CREATE YOUR OWN SCALE

Submitted by: Annadee Rylee

Grade Level: 2nd

Literacy:

Cho Chang Weighs an Elephant by Songju Ma Deamicke

STEM Content Standards:

Mathematics:

- AR.Math.Content.2.OA.B.2
    - Fluently add and subtract within 20 using mental strategies
    - By the end of Grade 2, know from memory all sums of two one-digit numbers
- AR.Math.Content.2.NBT.B.5
    - Add and subtract within 100 with computational fluency using strategies based on place value, properties of operations, and the relationship between addition and subtraction
- AR.Math.Content.2.MD.D.9
    - Generate data by measuring the same attribute of similar objects to the nearest whole unit
        - Display the measurement data by making a line plot, where the horizontal scale is marked off in whole- number units
        - Generate data from multiple measurements of the same object
        - Make a line plot, where the horizontal scale is marked off in whole-number units, to compare precision of measurements

Technology and Engineering:

Engineering, Technology, and Applications of Science

- 1-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.
- 1-ETS1-3 Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Standards for Technological Literacy

- **Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.**
    - In order to recognize the changes in society caused by the use of technology, students need to learn that: **K-2 Benchmarks** The use of tools and machines can be helpful or harmful.
- **Standard 9: Students will develop an understanding of engineering design.**
    - In order to comprehend engineering design, students should learn that:

- **K·2 Benchmarks**
  - A. The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.
  - B. Expressing ideas to others verbally and through sketches and models is an important part of the design process.
- **Standard 11: Students will develop abilities to apply the design process.**
  - As part of learning how to apply design processes, students should be able to:
  - **K-2 Benchmarks**
    - Brainstorm people's needs and wants and pick some problems that can be solved through the design process.
    - Build or construct an object using the design process.
    - Investigate how things are made and how they can be improved.

Big Ideas:

- Understanding how to create a scale
- Volume
- Bouncy
- Understanding when you drop in object into the water the water will rise
- The design process can help solve problems
- Use an electronic scale correctly to weigh items

People are constantly weighing things, at the grocery store, at the gym, and on the road. We have found an object that is to big fit on the electronic scales. However, there is a pond close by that the object will fit in. We will use this pond to weigh our objects and create a scale.

Essential Question:

How can you build a scale using an enclosed water area to weigh an object accurately?

Challenge:

- Students will have to be able to read an electronic scale
- Do math to add and subtract rise and fall of water
- Create a scale that is between 0-12 pounds that is useable
- Scale must be accurate
- Use the design process to come up with your final working scale

Limitations:

- The scale must be easy to read
- It cannot exceed 12 pounds
- Can only use 4 objects
- Can only weigh nontesting objects on the electronic scale

Materials:
The materials available to construct the scale are below. The teacher is free to add additional materials or substitute materials as needed.

1 –expomarker	1 – full 8oz glue bottle	1-1 quarter
1 –medium sized rock	1 – scissor	1– cucumber
1 - Wooden pencil	1 - Large paper clips	1 – orange

Testing Objects:

- an apple
- a stapler
- a big rock

Tools:
Each engineering design team will be able to use a ruler, fish tank and a scale.

Results (provide these items to the teacher for assessment)**:**

- Completed STEM design journal
- Accuracy of scale
- Presentation of completed scale

Teacher Video Resources: Introduce the unit by showing the YouTube® video below to your students. This video explain how to weigh objects and write a scale

- https://www.youtube.com/watch?v=Dj1rbIP8PHM
- https://www.youtube.com/watch?v=xK3vab2uRtI

Content Information:
Discuss the following content information before assigning the engineering design teams the task of constructing a water scale.

- In China in 200 AD they wanted to weigh an elephant but they didn't have a scale big enough. They used the way that the water rises when an object falls into it to weigh the object.
    - Volume: the amount of space that a substance or object occupies, or that is enclosed within a container, especially when great.
        - What does this mean? Answer: An object with greater volume will cause the water to rise a greater amount.
    - Buoyancy: the ability or tendency to float in water or air or some other fluid.
        - This means that some objects might not completely sink
- Discuss ways to measure the difference of the water with nothing and water with an object
- Discuss how to add and subtract the movement of the water rising and falling

Suggestions for the Teacher:

This STEM design challenge will help students understand how humans construct items to make life easier. This will help students understand the work it goes into weighing an object. The teacher should read, *Cho Chang Weighs an Elephant* by Songju Ma Deamicke, then discus the engineering process. They introduce how they are going to make their own water scale. The teacher should quickly demonstrate how to drop an object into the water and then see how much it causes the water to rise and mark it on the side of the fish tank. Then the teacher should weigh the object on the electric scale and discuss how they relate. The teacher should discuss how students will be evaluated by the way they work together, how neatly the scale is, and how well they work as a team. The teacher should discuss the limitations. The teacher should then let the students get into groups where they can try multiple objects on their own and create a scale. The teacher should hold back testing objects so that once everyone's scales are completed they can see how accurate their scales were.

Testing:

After each team has finished their water scales then they will each present it to the classroom. Each team will be handed the testing objects to drop into the water and decide the weight. They will all record the measurements they read. As a class they will compare them, then the teacher will weigh them on the electronic scale to get the more accurate reading. The team with the closest measurements will get a prize.

Teacher Evaluation: Racing to the Future

Scale was submitted along with completed journal	/10
Scale was creative and thought through	/20
Team clearly and effectively presented their scale to the class	/20
Scale was accurate	/20
Scale was easy to read	/10
It was evident that the team followed the design process to create their scale	/20
Total	**/100**
Additional Comments:	

A teacher assessment rubric is provided below. You could also provide students with scores for their scale, the accuracy, their team work, their completed STEM design journals, and their design presentations.

Name: Engineering Design Team Member Names:

STEM CHALLENGE

Title: Create your own scale

Grade Level: 2nd

Literacy Connection:

- *Cho Chang Weighs an Elephant* by Songju Ma Deamicke

Big Ideas:

- Understanding how to create a scale
- Volume
- Bouncy
- Understanding when you drop in object into the water the water will rise
- The design process can help solve problems
- Use an electronic scale correctly to weigh items

Scenario:
People are constantly weighing things, at the grocery store, at the gym, and on the road. We have found an object that is to big fit on the electronic scales. However, there is a pond close by that the object will fit in. We will use this pond to weigh our objects and create a scale.

Essential Question:
How can you build a scale using an enclosed water area to weigh an object accurately?
Challenge:

- Students will have to be able to read an electronic scale
- Do math to add and subtract rise and fall of water
- Create a scale that is between 0-12 pounds that is useable
- Scale must be accurate
- Use the design process to come up with your final working scale

Limitations:

- The scale must be easy to read
- It cannot exceed 12 pounds
- Can only use 4 objects
- Can only weigh non-testing objects on the electronic scale

Materials:

- The materials available to construct the scale are below. The teacher is free to add additional materials or substitute materials as needed.
-

1 –expomarker	1 – full 8oz glue bottle	1-1 quarter
1 –medium sized rock	1 – scissor	1– cucumber
1 - Wooden pencil	1 - Large paper clips	1 – orange

Tools:

Each engineering design team will be able to use a ruler, fish tank and a scale.

Results (provide these items to the teacher for assessment)**:**

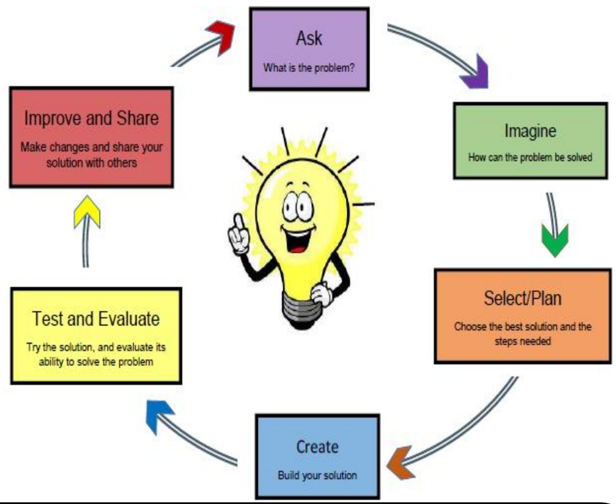
- Completed STEM design journal
- Accuracy of scale
- Presentation of completed scale

STEM DESIGN JOURNAL

Name:

Engineering Design Team Names:

What problem are you solving?



IMAGINE how you can solve this problem—What are some ideas for your scale?

OBSERVE- weigh some objects and record there weights from your water scale and electronic scale

DRAW the scale you selected-

TEST using testing objects from teacher and record-

IMPROVE & SHARE: Was your scale the best? What could you have done differently?

REFLECTION: Answer the following questions:

How did the water change once an object was dropped into it?

What object had the greatest impact on the water rising?

Why is that?

What had the least impact on the water rising?

Why is that?

STEM DESIGN JOURNAL

Submitted by: Hellman

Name:

Partner's Name:

Design Challenge:

Ask

Identify the problem that you have been asked to solve? State the problem in your own words.

____
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What questions do you need to ask in order to better understand the problem?

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What limitations do you have?

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Research

Conduct research.

What do you need to find out?

What did you find out?

Imagine

Sketch and describe three possible solutions.

Plan

You and your partner draw the solution you think is best. Explain why you think it is best.

Create

Create your model.

Test

How will you test your model?

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Collect data from your test.

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Improve and Share

How can you improve your design?

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Retest your model. How did your improvements work?

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Prepare to defend your solution. What do you like about your model?

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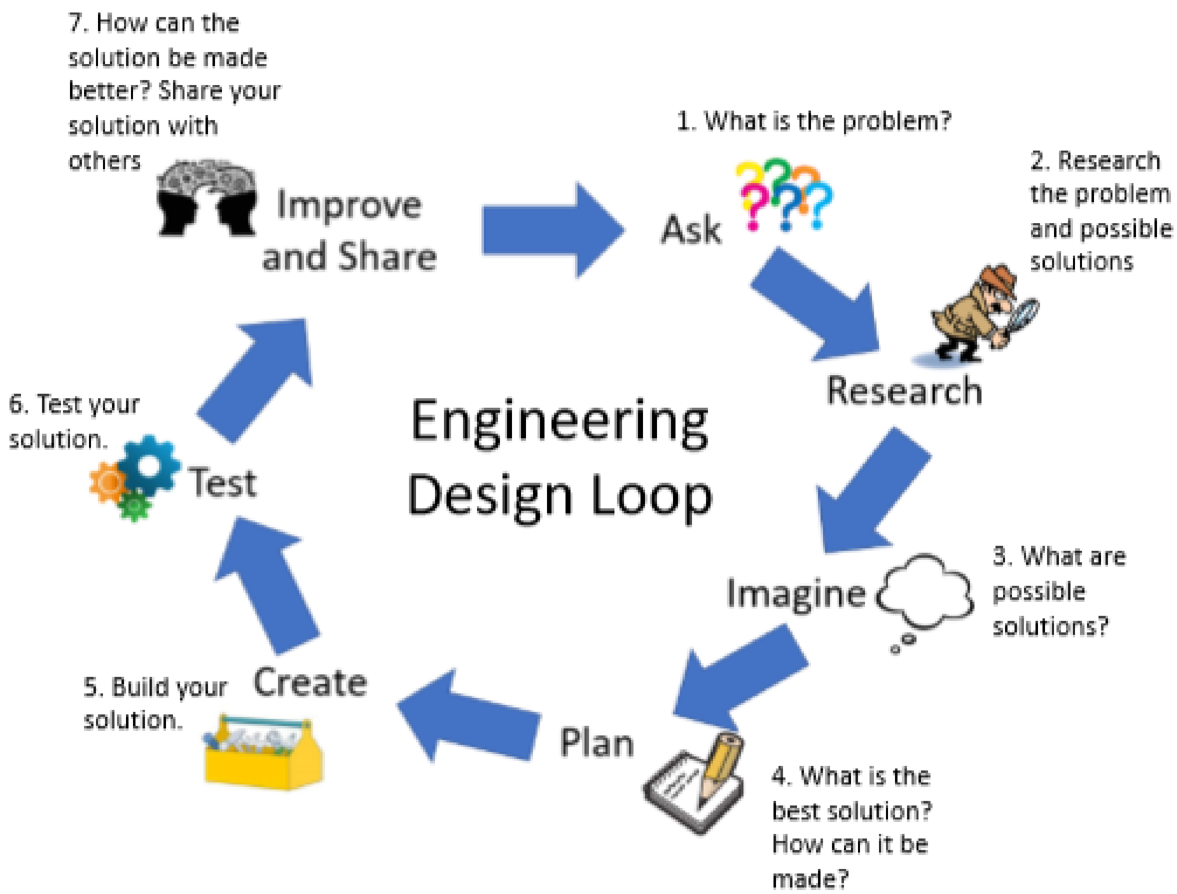
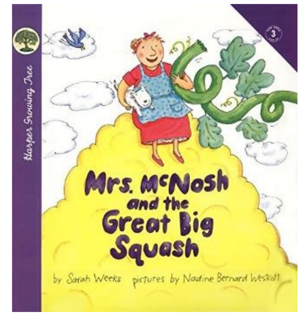
What still needs improvement?


7. How can the solution be made better? Share your solution with others
Improve and Share
1. What is the problem?
Ask
2. Research the problem and possible solutions
Research
Engineering Design Loop
6. Test your solution.
Test
Imagine
3. What are possible solutions?
5. Build your solution.
Create
Plan
4. What is the best solution? How can it be made?



SQUASH YOUR PROBLEM WITH ENGINEERING

Teacher Edition

Submitted by: Hellman

Grade Level: 1st Grade

Literacy Connection: Mrs. McNosh and the Great Big Squash by Sarah Weeks

STEM Content Standards:

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

1-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.

1-LS1-1 Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs.

Big Ideas:

- Engineering is working creatively to solve a problem.
- The Engineering Design Process allows people to be creative and find the best solutions to problems.
- There is not just one solution to any problem. Some solutions may be better than others but there are always multiples ways to solve a problem.
- Plants and animals use the resources available to them to solve problems (find water, shelter, sunlight, space, etc.)

Scenario:

“Now what do I do?” wondered Mrs. McNosh.

“I’ve got to find something to do with this squash. There isn’t a place in the world it will fit.”

You and your partner going to pretend that you are Mrs. McNosh, what are you going to do with your squash? You have a problem, now it’s your turn to decide what you are going to do with your squash. Brainstorm three possible inventions that you could make a fake squash. Draw your three possible solutions and explain them. Discuss with your partner your best solution and decide which solution you are going to make. Construct your squash invention. After you test your invention and make improvements, you and your partner will present your invention to the class.

Essential Question: What do you think the best solution is for Mrs. McNosh’s problem?

Challenge: Invent something using a fake squash and up to four of the materials given. The finished product must be able to fit into a shoe box.

Limitations:

- You will have 1 hour (60 minutes) to complete the STEM design journal and model of your invention
- Your squash invention has to fit within a shoe box
- You can use up to 4 materials

Materials:

- Design Journal
- Engineering Design Loop
- Fake squash
- Toothpicks
- Pipe cleaners
- Cardboard
- Straws
- Rubber bands
- String
- Paper clips

Tools:

- Scissors
- Box Knives
- Glue
- Markers, crayons, colored pencils
- Tape

Results: After the students have presented their models to the class, they will need to turn in their models, STEM Design Journals, and Results/Reflection Worksheet.

Content Information:

Problem- Something that is hard to understand, deal with, or correct

Solutions- An answer to a problem

Engineering- The science of developing and using nature's power and resources in ways that are useful to people

Teacher Video Resources:

What's an Engineer?

https://www.youtube.com/watch?v=owHF9iLyxic

Engineering Design Process Rap

https://www.youtube.com/watch?v=6dR3iKaWUoU

Different Types of Squashes

https://www.youtube.com/watch?v=4m84WRbbP60

Suggestions for the Teacher:

Procedures:

1. Ask your students what they already know about engineering and problem solving. Hold a class discussion. This is where you could show the What's an Engineer? Video.
2. Introduce and read the text to your class. Discuss the text with your students. Ask their opinions of the story. Ask what experiences they've had with squashes. This is where you can show the different types of squashes video. Ask your students what problem Mrs. McNosh came across. Ask your students how she solved her problem.
3. Explain the activity to your students. Walk your students through the STEM Design Journal and the Engineering Design Loop. Explain how this activity can be related to plants and animals solve their problems (survive).
4. Let your students start the activity. Walk around and be available to answer questions and help them through the design process. Be sure you let them know how much time they have through the hour.
5. Once all your students have finished, hold a discussion about their thoughts on the activity. Also, discuss the challenges they faced during the process.
6. Have your students come up with their partners and have them present their models.
7. Once all of your students have presented, have them turn in their inventions, STEM Design Journal, and Results/Reflection Worksheet for assessment.

Questions to ask your students:

- When you have a problem, how do you solve it?
- Have you ever had a problem you couldn't solve?
- What do you know about engineering?
- Has anyone seen a squash before? Has anyone eaten a squash before?
- Why do you think you aren't allowed to use more than four materials?
- Why do you think your final invention has to be able to fit into a shoe box?
- Why do we use the Engineering Design Loop?
- Why do we use the STEM Design Journal?

Testing: You will need to walk around the class monitoring the student's discussions to see if the students understand the concepts that have been taught. You will also be able to assess students by asking them questions and analyzing their answers. You can asses the students by looking at their STEM Design Journals to see if they understood how to use the process and how they used it to solve the problem.

Teacher Evaluation:

	20 points	15 points	10 points	5 points	0 points	
Produced an invention of high quality while completing the STEM Design Journal.						
Accurately completed assigned tasks associated with the problem within timeframes established by the instructor.						
The team functioned at a high level—with all members carrying out specific roles and contributing equally.						
Submitted their model, STEM Design Journal, and Result/Reflection Worksheet.						
Used their creativity.						
Total						*/100*

Squash Your Problems with Engineering

Student Edition

Names of Engineering Design Team Members:

Design Challenge:

"Now what do I do?" wondered Mrs. McNosh.

"I've got to find something to do with this squash. There isn't a place in the world it will fit."

You and your partner going to pretend that you are Mrs. McNosh, what are you going to do with your squash? You have a problem, now it's your turn to decide what you are going to do with your squash. Brainstorm three possible inventions that you could make a fake squash. Draw your three possible solutions and explain them. Discuss with your partner your best solution and decide which solution you are going to make. Construct your squash invention. After testing your invention and make improvements, you and your partner will share your invention to the class.

Limitations:

- You will have 1 hour (60 minutes) to complete the STEM design journal and build a model of their squash inventions.
- You will be allowed to choose up to four materials from the list below.
- Your final invention must be able to fit in a shoe box.

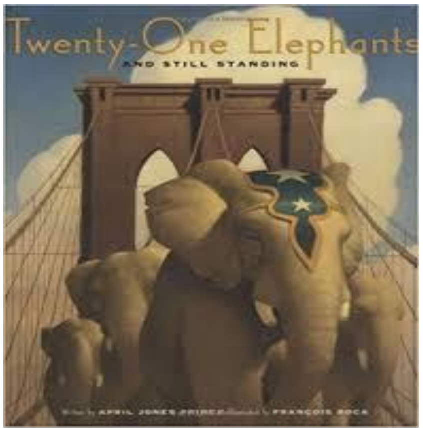
Available Tools and Materials:

- Toothpicks
- Pipe cleaners
- Cardboard
- Straws
- Rubber bands
- String
- Paperclips
- Scissors
- Box knives
- Glue
- Markers, crayons, colored pencils
- Tape

Be sure to turn in these things after your presentation to the class:

- Final Invention
- STEM Design Journal
- Results/Reflection Worksheet

	20 points	15 points	10 points	5 points	0 points	
Produced an invention of high quality while completing the STEM Design Journal.						
Accurately completed assigned tasks associated with the problem within timeframes established by the instructor.						
The team functioned at a high level—with all members carrying out specific roles and contributing equally.						
Submitted their model, STEM Design Journal, and Result/Reflection Worksheet.						
Used their creativity.						
Total						*/100*



<u>STEM CHALLENGE</u>

TWENTY-ONE ELEPHANTS AND STILL STANDING

Written by: April Jones Prince

Submitted by: Greear

Grade Level: 2^{nd} – 4^{th} Grade

Literacy Connection:

STEM Content Standards:

<u>Science:</u>

- 2-PS1-2 – Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

<u>Technology and Engineering:</u>

- 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.

<u>Mathematics</u>

- MP.2 Reason abstractly and quantitatively

- AR.Math.Content.4.MD.A.2 : Solve word problems involving dollar bills, quarters, dimes, nickels, and pennies, using dollar ($) and cent (¢) symbols appropriately.

Standards for Technological Literacy:

- Standard 1- Students will develop an understanding of the characteristics and scope of technology.
  - B. All people use tools and techniques to help them do things.
- Standard 2 – Students will develop an understanding of the core concepts of technology
  - B. Systems have parts or components that work together to accomplish a goal.
  - C. Tools are simple objects that help humans complete tasks.
  - D. Different materials are used to making things.
  - E. People plan in order to get things done.
- Standard 8 – Students will develop an understanding of the attributes of design.
  - A. Everyone can design solutions to a problem.
  - B. Design is a creative process.
  - C. The design process is a purposeful method of planning solution to problems.
- Standard 11 – Students will develop abilities to apply the design process.
  - B. Build or construct an object using the design process.
  - C. Investigate how things are made and how they can be improved.

Big Ideas:

- The shape of a bridge is a key aspect of how effective the bridge will be.
- The structure of a bridge determines the strength of a bridge and how much weight it can endure.

- The engineering design loop process can be used to create different bridge structures.

Essential Question: How can you build an effective bridge using your knowledge of structure and shape to make sure the bridge can withstand the weight of many different objects?

Scenario: Using the engineering design process and what you have learned about structures, mass, and weight, can you build a bridge that can withstand the weight of multiple objects? Your friends just bought an island to build your dream fort or mansion on. You must a build a bridge that connects your island to the mainland so that you can cross and bring supplies to build your fort/mansion.

Challenge:

To build the bridge that connects your island to the mainland, use supplies available to create a bridge whose structure and shape will allow for you to bring across the most supplies to your island. Each group will be given $5.00 to purchase materials to construct their bridge. You can also trade supplies with other groups, but only if they want to.

Limitations:

Your bridge must:

- Be designed with the supplies provided by the teacher.
- Have a distinct design shape.
- Must be at least 4” by 8”

- Each bridge must hold at least 3 golf balls.
- Must include at least three different materials to build the bridge.
- Each group will be given $5.00 to purchase materials with.

Materials:

- Toothpicks
- Twizzlers
- Gumdrops
- Pipe-cleaners
- Straws
- Paperclips
- Safety Pins
- Colored paper
- Rubber bands

Tools:

- Scissors
- Pens/pencils
- Markers
- Paper
- Glue
- Tape

Results:

- Complete STEM design journal
- Presentation of bridge design
- Amount of supplies the bridge can carry across

Content Information:

Discuss the following content information before assigning engineering design teams the task of constructing a bridge.

- Vocabulary:
    - Deck – the part of the bridge you travel on.
    - Truss – help a bridge spread out the weight the bridge has to carry; a stretching force that pulls on a material
    - Tension – pulling something tight
    - Force – any action that tends to maintain or alter the position of a structure
    - Arch Bridge – a curved structure that converts the downward force of its own weight, and of any weight pressing down on top of it, into an outward force along its sides and base.
    - Beam – a rigid, usually horizontal structural element
    - Beam bridge – a simple type of bridge, composed of horizontal beams supported by vertical posts
    - Brace – a structural support; to strengthen and stiffen a structure to resist loads
    - Cable-stayed bridge – a bridge in which the roadway deck is suspended from cables and anchored to one or more towers

- Price of building materials

Materials	Price
• Toothpicks • Twizzlers • Gumdrops • Pipe-cleansers • Straws • Paperclips • Safety Pins • Colored Paper • Rubber bands	• 10 for $1.25 • 4 for $1.17 • 1 for $0.52 • 3 for $0.73 • 7 for $1.00 • 2 for $0.43 • 3 for $0.87 • 1 for $0.05 • 3 for $0.99

  - Varying the cost of materials allows for the students to practice their adding and subtracting skills.
  - Students also practice counting money and rationing materials and money.

Introducing the Design Challenge:

- After introducing the content and challenge to your students**:**
    - Discuss the engineering design process and the role it plays in solving the problem.
    - Assign the students to engineering design teams (2-3 students per team is ideal). Tell them they will be evaluated on how well they solve the problem and for how well they work as a team.
    - Provide the students with the *Student Edition* and discuss the parameters for the activity (time, materials, testing, and evaluation, etc.)
    - Provide students with $5.00 in different bills and cents to purchase supplies with.
    - As the teams start their work, make sure that they are using the engineering design process (brainstorming, generating multiple potential solutions, etc.)
    - After each team has built their bridge, they will need to test the amount of materials their bridge can hold. They will place as many as the provided items on their bridge as they can without it collapsing or bending.
    - After recording how many materials their bridge was able to withstand, remind them to complete the modification part of the process in their design journals.
    - Teams should submit their bridges and worksheets for assessment.
    - <u>Optional</u>: Winning teams get a prize!

Teacher Tip: Introduce bridge designs and spark creativity by watching these videos. The first video offers more information on how and why a bridge is strong. The second video contains the top "12 Most Amazing Bridges Ever Build" that shows the most unique bridges ever built. This video can help spark creativity.

https://www.youtube.com/watch?v=oVOnRPefcno

https://www.youtube.com/watch?v=hz6ghvVbKpY&t=32s

Testing:

After each design team completes their bridge, ask them to present their bridge to the class. During the presentation, they should describe what three materials they used and why, explain the significance of their structure and its shape, and why this bridge design was the best solution to their problem. Once the students present their bridge, have the students test their bridges strength by placing a wide variety of objects on top of their bridge (each object should represent any supplies they might need on their island: building supplies, food, water, trucks, etc.). See which bridge can hold the most supplies. Once the strongest bridge is determined asked the students why they think that bridge in particular was able to hold the most materials? Look at the structure as a class. You can also ask the students why they took different supplies across to the island.

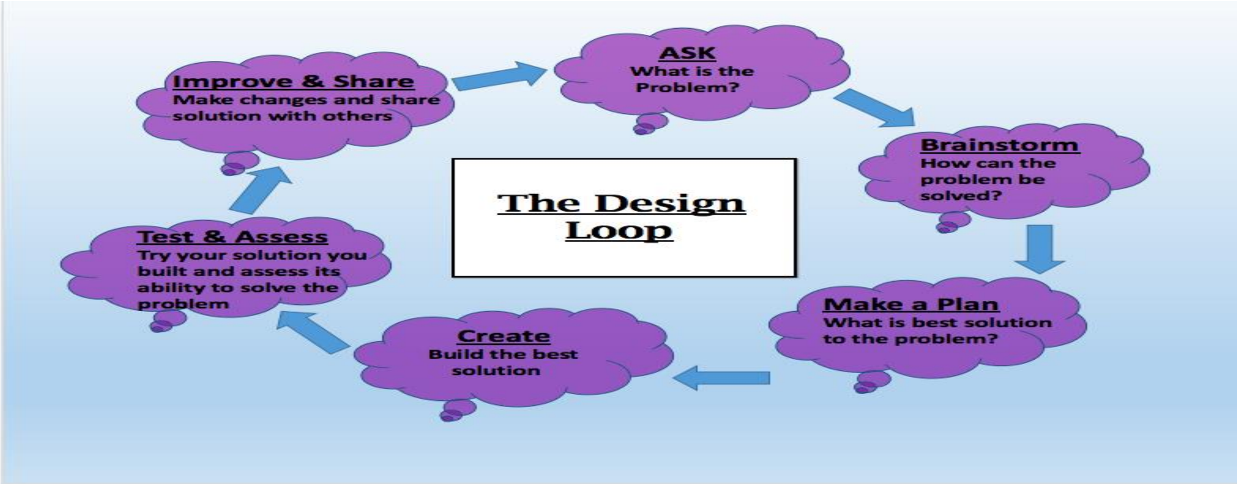
Bridge was submitted along with completed journal	/10
Bridge demonstrated creative, thoughtful, and intentional use of materials to carry out design	/20
Team clearly and effectively presented their bridge to others in the class	/20
Bridge held the minimum weight requirement of holding 3 golf balls	/20
Bridge was easily accessible	/10
It was evident that the team followed the design process to create their bridge	/20
Total	**/100**
Additional Comments:	

Teacher Evaluation:

A teacher assessment rubric is provided above. You can also provide students with scores for their completed bridge, the weight it was able to stand, their completed STEM design journals, and their design presentation.

Name: Engineering Design Team Member Names:

STEM DESIGN JOURNAL



Name:

Engineering Design Team Names:

IMAGINE how you can solve this problem—draw 2-3 sketches of different bridge designs.

SELECT the best bridge design show be drawn here.

CREATE your solution—What materials will you use to build your bridge?

TEST your bridge...

Is it sturdy?

IMPROVE & SHARE: Can you improve your bridge?

REFLECTION: Answer the following questions:

What forces occur on the bridge when you place supplies on it?

How did the materials you used for your bridge effect its strength?

How did the shapes you used for your bridge effect its strength?

Which materials worked best in constructing a bridge?

Why did your team select this design, instead of another?

AN INTRODUCTION TO STRUCTURES AND SHAPES

Name of Team Members:

Design Challenge:

To build the bridge that connects your island to the mainland, use supplies available to create a bridge whose structure and shape will allow for you to bring across the most supplies to your island. **:** Using the engineering design process and what you have learned about structures, mass, and weight, can you build a bridge that can withstand the weight of multiple objects?

Your friends just bought an island to build your dream fort or mansion on. You must a build a bridge that connects your island to the mainland so that you can cross and bring supplies to build your fort/mansion. You will be given $5.00 to purchase your materials for your bridge. You may also trade with surrounding groups, but only if they are willing to.

Tools and Materials:

Materials:	Tools:
• Toothpicks • Twizzlers • Gumdrops • Pipe-cleaners • Straws • Paperclips	• Scissors • Pens/Pencils • Markers • Paper • Glue • Tape

• Safety Pins • Colored paper • Rubber bands	

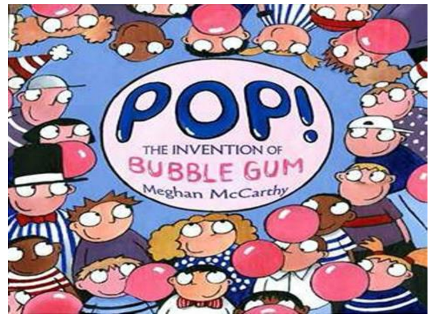
<u>Price of Building Materials:</u>

Materials	Price
• Toothpicks • Twizzlers • Gumdrops • Pipe-cleansers • Straws • Paperclips • Safety Pins • Colored Paper • Rubber bands	• 10 for $1.25 • 4 for $1.17 • 1 for $0.52 • 3 for $0.73 • 7 for $1.00 • 2 for $0.43 • 3 for $0.87 • 1 for $0.05 • 3 for $0.99

To Do List:

- Complete STEM design journal
- Presentation of bridge design
- Amount of supplies the bridge can carry across

Preparing for Take Off Brainstorm:



STEM CHALLENGE

POP! THE INVENTION OF… (**Teacher Edition**)

Submitted by: Payton Beall
Grade Level: 2nd
Literacy Connection:

Pop! The Invention of Bubblegum by Meghan McCarthy

STEM Content Standards:

Science:
Physical Science:
- 2-PS1-3 – Make observations to construct evidence- based account of how an object made a small set of pieces can be disassembled and made into a new object.

Technology and Engineering:
Engineering, Technology, and Applications of Science

- 4-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.

Mathematics:
Measurement and Data

- AR.Math.Content.2.MD.A.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Big Ideas:
- *That 'innovation' means a new method, idea, or product and 'invention' means something that has been created.*
- *Designing something is a creative process that takes many steps.*

- When innovating a product, you will have to trouble-shoot, research, develop, and sometimes repeat the process until your product is ready to share.
- Each person has a different way of thinking, therefor will create different inventions.
- The engineering design process can help people solve common problems.

Scenario:
Humans are constantly searching for the next best thing and are constantly wanting to create the better version of something. After reading Pop! The Invention of Bubblegum, you realize that everyone has the ability to become an innovator and every person has a different creation to make and a different way to create that. Work and follow your engineering design loop to build a creation of your own that will be appealing to your audience. In this instance we are gearing our innovation towards bettering 2nd grade school supplies. You will be given three options to choose from. First being, creating the best pencil possible for a 2nd grader. Second, creating a way to carry your books without causing damage to your back with all of that heavy weight. Lastly, creating a better safety system for your lockers. You will need to design your new innovation using the resources available below. You will only be allowed to pick 5 of the resource materials listed in the graph. Be creative in your ideas and use your resources wisely. You must plan your idea in the STEM design journal before starting to build. You will be presenting your creation to the class “Shark Tank” style and will be rewarded with candy money for the winning creation.

Essential Question:
How can you use certain materials given to make a new innovation that is useful and appealing to an audience?

Challenge:
- Design and build an invention/innovation that is useful and appealing to 2nd graders.
- Make sure to design the product with only materials given.
- Complete each step of the STEM design journal.
- The final product must meet the limitations of the design challenge below.

Limitations:
- The innovation must be easy to set up and operate.
- The innovation must be designed using only the materials provided below.
- The innovation must be presented to the other teams when it is complete.
- The innovation must be designed to appeal to the audience and be sturdy.
- You will have 30 minutes to build your creation.

Materials:
The materials available to construct a prototype for an invention for 2nd graders are below. The teacher is free to add additional materials or substitute materials as needed. Students will be able to choose 5 of the materials listed below to build their creation.

1 – 30 cm length duct tape	1 – 12 inch string	2 – Paper Plates
1 - Heavy rubber band	3 – Wood planks	4 – Wooden craft sticks
2 - Wooden pencils	6 – 12 inch metal links	5 - Plastic drinking straws
1 – Metal lock	3 – Pieces of lead	2 – Umbrellas

Tools:
Each engineer will be able to use scissors, wood saw, hot glue, drills, duct tape, and measuring tools.

Results (provide these items to the teacher for assessment)**:**

- Completed STEM design journal
- Presentation of completed invention or prototype
- Amount of votes given during invention competition. Students will each have a piece of candy and they will give their candy to the groups whose product they would buy. The innovator with the largest amount of candy (votes) will win Shark Tank: Candy Addition.

Content Information:
Discuss the following content information before assigning the engineering design teams the task of constructing an invention/innovation for 2nd graders.

  - Read the book, Pop! The Invention of Bubblegum. Explain to them what an inventor is versus and innovator. In order to invent something, it must have never been done before and an innovation is building a better or more efficient way to an object or item that has already been created.
    - So if I create the latest and greatest photo frame that has digital pictures that automatically rotate, would that be an invention or innovation? <u>Answer:</u> This is an innovation, because you didn't create the photo frame, you created a better version.

- A quick explanation of the three different problems needing solutions that the students can choose from would be a great way to start off the activity so they know their options.
- Before the students start building, take a moment to talk about prototypes and mock-ups. A prototype is a working model of a product which is made to test the design. Whereas a mock- up is an appearance of a product which show how and object will look. You might ask your students, depending on which you would like them to present. To use student's full potential of creativity, it would be smart to let them create a mock-up of what the product would look like and let them explain, what other items would be needed in order to actually make their product work
- How do we use this information to create a solution to our posed problems?
  - We will be making innovations out of the materials given
  - A mock-up will be created, and you will explain your innovation to your peers.
  - The innovation needs to appeal to students your age (2nd grade)
- Discuss measuring techniques. Younger students may want to measure using common materials (i.e., the creation will be one pencil length tall).
- Discuss how designers combine materials to make products strong, attractive, functional, and inexpensive.
- Discuss how the engineering design teams can use the engineering design process (see STEM design journal in the student edition) to help them create a successful design.

- Provide the engineering design teams with certain materials to become familiar with and let them brainstorm on what problem they would like to solve. Ask the teams questions like the following:
    - "How will you appeal to boys and girls in your school?"
    - "How many materials will you need to complete your ideal design?"
    - "How will you present your product to the class?"
    - "How will you prevent your idea from being taken from you by your classmates?"
- Introduce the following vocabulary words associated with this unit of study:
    - <u>Invention:</u> A new product, system, or Process that has never existed before
    - <u>Engineering:</u> The practical application of science and math to solve problems
    - <u>Innovation</u>: Improvement to an existing technological product, system, or method.
    - <u>Criteria</u> The requirements of a problem
    - <u>Constraints</u>: the limitations of a problem
    - <u>Design</u>: The act of creative planning used to solve a problem
    - <u>Prototype</u>: A working model of a product which is made to test the design
    - <u>Mock-up:</u> An appearance of a product which show how and object will look.
    - <u>Patent:</u> A grant that gives the creator of an invention the right to sell the product.
    - <u>Model:</u> A three dimensional copy of a product
    - <u>Attribute:</u> a feature of a product
    - <u>Technology:</u> The use of tools and systems to make life easier and better.
    - <u>Design Brief:</u> A document that clearly describes the problem, criteria, and constraints of a design.

Teacher Video Resources:
Introduce the unit by showing the YouTube® videos below to your students. These two videos explain the differences between innovation and invention. The invention video should be shown last in order to leave a lasting impression and the video is with Kid President, so it will be memorable and a light-hearted video for the students

- https://www.youtube.com/watch?v=IiyMkOfycOg (Video on Innovation)
- https://www.youtube.com/watch?v=75okexRzWMk (Video on Invention- Kid President)

Suggestions for the Teacher:
This STEM design challenge will help students understand how humans construct items to make life easier. The challenge will also help students understand more about innovation, invention, prototypes, mock ups, and other creation concepts. The challenge will also help advance students' previous knowledge about creating solutions to various problems with different materials. Discuss the engineering design process and the role it plays in solving. Tell them that they will be evaluated on how well they solve the problem and how well they work to provide a product that will appeal to many audiences. Provide the students with the *student edition* and discuss the limitations for the activity (time, materials, testing, evaluation, etc.). As they start their work, make sure that they are using the engineering design process (brainstorming,

generating multiple potential solutions, etc.) included in the STEM design journal (in the Student Edition).

Testing:

After each team has completed their design, ask them to prepare a short presentation on their creation. During this presentation, they will describe how their creation resolves one of the three problems that were given out by the teacher. They will describe how they created their new innovation and why they thought their creation was the most efficient. Students will be presenting in a "Shark Tank" environment. There will be a panel of judges (a few teachers) who will ask questions that will cause the students to think on their feet and be able to have a good reason of why they chose and created what they did. After each innovator has presented their creation. Each innovator will be given one piece of candy. The way to test who has the best innovation for a 2nd grader, is each person will leave a piece of candy on the creation that they would want to buy and that they thought was the best out of all of the class' creations. The teacher will tally up the pieces of candy as votes, and the winner will be awarded with all of the candy, as a substitution for money.

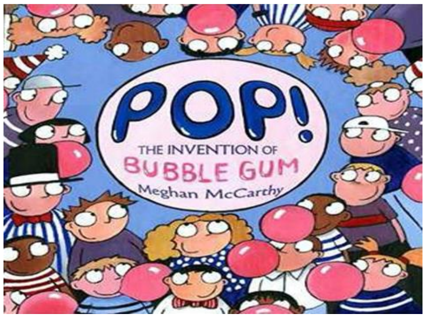
  - Students can only give their candy money to one innovator.
  - Students are not allowed to give candy to themselves.
  - Remember, the challenge is to create something that is efficient and appeals to your audience!
- After all innovators have completed their final product and completed their journals, students will be asked to describe their attempt to solve the problem orally to the remainder of the class.
  - The presentation should include a discussion of the process they went through to choose which problem they wanted to solve, whether they innovated or invented, and whether it was a mock up or prototype.
- Teams should submit their creation and STEM design journal for assessment.
- Optional: Present the willing team with a prize for first place! (CANDY!)

Teacher Evaluation: POP! The Invention of…
A teacher assessment rubric is provided below. You could also provide students with scores for their completed creation, the creation's ability to work, their completed STEM design journals, and their design presentations.

Name: Engineering Design Name:

Creation was submitted along with completed journal	/10
Creation demonstrated creative, thoughtful, and intentional use of materials to carry out design	/20
Member clearly and effectively presented their creation to others in the class	/20
Creation actually worked when their peers used it	/20
Creation was easy to operate	/10
It was evident that the member followed the design process to build their creation	/20
Total	**/100**
Additional Comments:	

STEM CHALLENGE



Title: POP! The Invention of… (**Student Edition**)

Grade Level: 2nd

Literacy Connection: Pop! The Invention of Bubblegum by: Meghan McCarthy

Big Ideas:

- *That 'innovation' means a new method, idea, or product and 'invention' means something that has been created.*
- *Designing something is a creative process that takes many steps.*
- When innovating a product, you will have to trouble-shoot, research, develop, and sometimes repeat the process until your product is ready to share.
- Each person has a different way of thinking, therefor will create different inventions.
- The engineering design process can help people solve common problems.

Scenario:

Humans are constantly searching for the next best thing and are constantly wanting to create the better version of something. After reading Pop! The Invention of Bubblegum, you realize that everyone has the ability to become an innovator and every person has a different creation to make and a different way to create that. Work and follow your engineering design loop to build a creation of your own that will be appealing to your audience. In this instance we are gearing our innovation towards bettering 2nd grade school supplies. You will be given three options to choose from. First being, creating the best pencil possible for a 2nd grader. Second, creating a way to carry your books without causing damage to your back with all of that heavy weight. Lastly, creating a better safety system for your lockers. You will need to design your new innovation using the resources available below. You will only be allowed to pick 5 of the resource materials listed in the graph. Be creative in your ideas and use your resources wisely. You must plan your idea in the STEM design journal before starting to build. You will be presenting your creation to the class "Shark Tank" style and will be rewarded with candy money for the winning creation.

Essential Question:

How can you use certain materials given to make a new innovation that is useful and appealing to an audience?

Challenge:

- Design and build an invention that is useful and appealing to an audience
- Make sure to design the product with only materials given
- Complete each step of the STEM design journal
- The final product must meet the limitations of the design challenge below

Limitations:

- The innovation must be easy to set up and operate
- The innovation must be designed using only the materials provided below
- The innovation must be presented to the other teams when it is complete
- The innovation must be designed to appeal to the audience and be sturdy
- You will have 30 minutes to complete your creation

Materials:

The materials available to construct the vehicle are below. The teacher is free to add additional materials or substitute materials as needed. Each innovator will be able to pick 5 of the materials offered below in order to build their creation.

1 – 30 cm length duct tape	1 – 12 inch string	2 – Paper Plates
1 - Heavy rubber band	3 – Wood planks	4 – Wooden craft sticks
2 - Wooden pencils	6 – 12 inch metal links	5 - Plastic drinking straws
1 – Metal lock	3 – Pieces of lead	2 – Umbrellas

Tools:

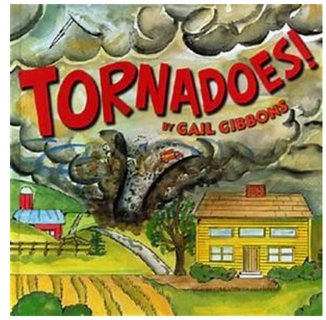
Each engineer will be able to use scissors, wood saw, hot glue, drills, duct tape, and measuring tools

Results: (provide these items to the teacher for assessment)**:**

- Completed STEM design journal
- Presentation of completed invention or prototype

Amount of votes given during invention competition. Students will each have a piece of candy and they will give their candy to the groups whose product they would buy. The innovator with the largest amount of candy (votes) will win Shark Tank: Candy Addition

(Teacher Edition)



Submitted by: DeClerk
Grade Level: 3rd grade

Literacy Connection: *Tornadoes* by Gail Gibbons

STEM Content Standards:

Science:

- 3-ESS3-1- **Make a claim about the merit of a design solution that reduces the impacts of a weather-related hazard.**

Technology and Engineering:

- 3-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-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.**

Math:

- **2.MD.A.1-** Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes

Big Ideas:

- Understand the magnitude of destruction a tornado, producing winds exceeding 250 mph, can cause.
- Understand the engineering behind building shelters sturdy enough to withstand tornado winds.
- Understand basic tornado safety precautions.

Content Information:

Science:

- A tornado is a rotating column of air ranging in width from a few yards to more than a mile and whirling in a circular motion at destructively high speeds.

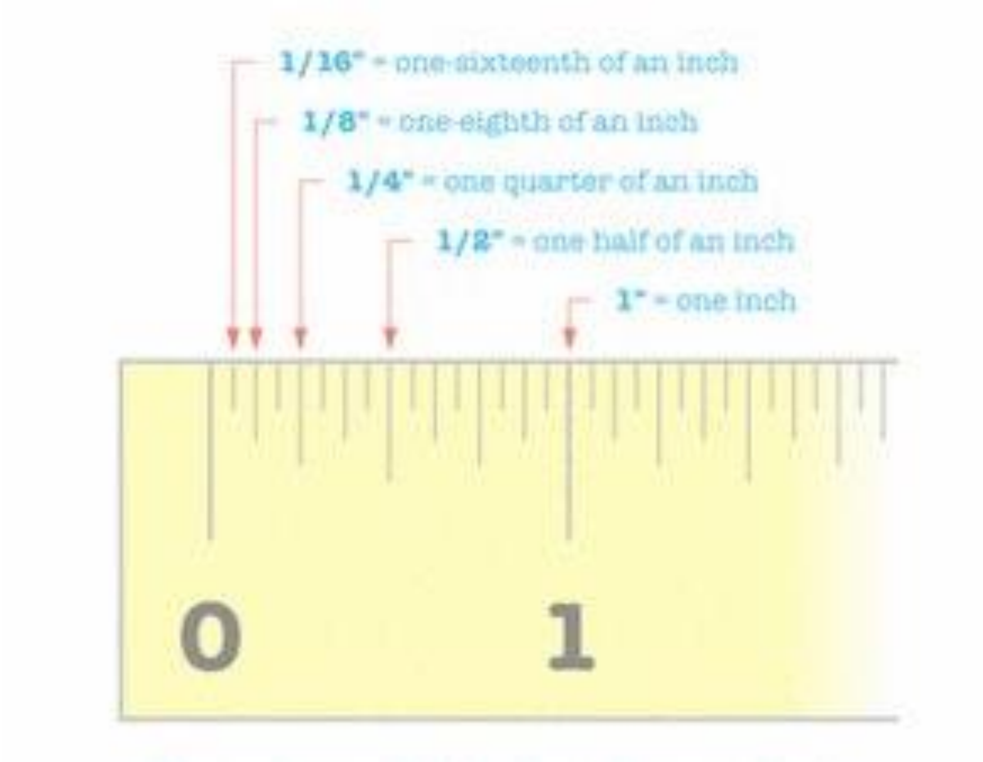
- Tornadoes can produce winds exceeding 250 mph and can move objects up to 100 miles from where they started
- The Fujita Tornado Damage Scale, or F-Scale is the only scale that exists for rating tornadoes
    - Tornadoes are measured by looking at their speed, diameter and how much damage they leave behind.

Engineering:

- To test the strength and durability of materials and construction methods, engineers re-create tornado conditions. Engineers test and look for sturdy reinforcing materials for components of a home such as the roof shingles and roof design, house walls, and the foundation.
- Concrete foundations increase the strength and durability of a building
    - The best place to be during a tornado is in a basement or storm cellar because they are surrounded by concrete
- Windows are something you should avoid being around during a tornado. This is because windows are made of glass, which is a material that is not very strong and durable when it comes to protecting you from the tremendous winds produced by a tornado.
    - The second best place to be during a tornado is an interior room without windows

Math:

- Before the students start building, take time to go over how to measure materials with a ruler. This will help students be able to meet the measurement requirements of the house they are building.
    - You should always start their measurement at the "zero mark"
        - Some rulers have a zero mark at the end of a ruler, but some rulers have a small space from their edge before the actual readings start.
    - After lining one end of the material you are measuring up with the zero mark, you simply find where the other end of the material lines up on the ruler markings and determine what that number is.
        - When looking at the inches side of the ruler, the smallest markings = 1/16 of an inch. The second smallest markings = 1/8 of an inch. The third smallest markings= 1/4 of an inch. The fourth smallest markings = 1/2 of an inch. The largest markings are 1 inch.
        - This picture would be a great illustration to draw and go through with students.



Essential Question:

You now have a clear understanding of how powerful tornadoes can be and how destructive they can be to a city or town. You have a strong grasp on the engineering required to develop a solid reinforced structure that can withstand tornado winds. You also have knowledge of basic tornado safety precautions. Now that you have acquired all of this knowledge, how can you use this information as a helpful tool for planning and constructing a building structure that can withstand the strong winds of tornadoes?

Scenario:

Tornadoes can create major destruction within a city/town. In the book we read about tornadoes, we learned how much wind force a tornado can produce along with the damage a tornado can cause to a home or building. For this lesson we are going to travel back in time to the year of 2011 when a destructive tornado steamrolled through Joplin Missouri. According to CNN, more than 1,000 people were injured by the tornado's packed winds of more than 200 mph. CNN also reported the storm damaged or destroyed 7,500 residences and 500 businesses, displaced 9,200 people, affected 5,000 employees and generated 3 million cubic yards of debris. The community of Joplin is working hard to rebuild their city in a way that will prepare them for any tornadoes that come their way in the future. The main priority is coming up with a building structure that is reinforced and sturdy enough to withstand the powerful winds of a tornado. You are all engineers working on this project. Your job is to create and build a house that the city of Joplin can implement in their city wide rebuild plan.

<u>Tools, Materials, and Resources:</u>

Materials:

- Popsicle sticks
- duck tape
- paper clips
- card board
- rubber bands
- string

Resources:

- glue
- scissors
- ruler

<u>Limitations:</u>

- Must only use the materials provided
- Building designs but be at least 6 inches tall, 6 inches wide, and 6 inches long.

<u>Evaluation:</u>

- After students have created their designs and tested them, you will go around and make sure each house meets the measurement requirements. Then, each group will present their work to you and the class (representing the city of Joplin Board of Directors). Students should explain what factors were considered when creating this design and why they believe their design will be the best for protecting the residents of Joplin from future tornadoes that come their way. Students should include their results after testing as well.

<u>Introducing the Design Challenge:</u>

After introducing the content information listed above:

1. Read *Tornadoes* by Gail Gibbons to the class
2. Discuss with students how tornadoes can destroy buildings. Talk about how fast the

winds from the tornadoes are, the debris that is flying through the air, and talk about situations in the book where buildings were destroyed. Make sure to guide the students through a discussion with open ended questions, allowing them to think for themselves.

3. Tell the students that they will be designing their own tornado-proof house in small teams. Introduce the scenario above to the students, so they can start putting themselves in the frame of mind of an engineer working on a very important project. Remind the students of the previous class destruction we had as well as the content information given at the beginning of the lesson. Students should use all of this information as a tool for creating a house that can withstand the destructive winds of a tornado. Encourage students to be creative and think outside the box when brainstorming and planning their houses.

4. Assign the students to engineering design teams (groups of 3-4 students). Have the groups come up with their own engineering firm name.

5. Provide the students with the student edition and discuss the parameters for the activity (limitations, materials, testing, evaluation, etc.). During this time, you will also discuss how to use a ruler for measuring the materials they will be working with. This will be to help make sure they meet the measurement requirements of their house.

6. Remind the students of the Engineering Design Process and how they should use this tool when trying to solve the problem you have given them.

7. Once each team has designed their final product, it is time to start testing! To do this, you will use a leaf blower, which will symbolize the tornado plowing through the city. You will see how well the house holds its' structure after facing the force of the leaf blower.

8. Each team will have 2 opportunities to test their house before presenting to the city of Joplin board of directors (the class and you)

9. After each team has gone through their testing period, they will record their results on their worksheets.

10. Finally, each team will present their house structures to the class and you. Students should discuss their process to get to their final product and what their results were.

11. Present the winning team with a plack from the city of Joplin, thanking them for their contributions with rebuilding their community!

Teacher Evaluation Rubric:

Teams house and journal was submitted along with completed journal	/10
Team demonstrated their understanding of the magnitude of destruction a tornado can have. Team also demonstrated their understanding of the engineering behind creating a building design that is sturdy and strong enough to withstand a tornado's tremendous winds.	/20
Team clearly and effectively presented their house design to others in the class	/20
House design withheld the strong winds of a tornado "leaf blower"	/20
The house design met measurement requirements	/10
It was evident that the team followed the design process to create their house design	/20
Total	**/100**
Additional Comments:	

The Battle between Engineers and the Forces of Tornadoes

(Student Edition)

Names of Engineering Design Team Members: _____________, _____________,
_____________, _____________,

Design Challenge:

Tornadoes can create major destruction within a city/town. In the book we read about tornadoes, we learned how much wind force a tornado can produce along with the damage a tornado can cause to a home or building. For this lesson we are going to travel back in time to the year of 2011 when a destructive tornado steamrolled through Joplin Missouri. According to CNN, more than 1,000 people were injured by the tornado's packed winds of more than 200 mph. CNN also reported the storm damaged or destroyed 7,500 residences and 500 businesses, displaced 9,200 people, affected 5,000 employees and generated 3 million cubic yards of debris. The community of Joplin is working hard to rebuild their city in a way that will prepare them for any tornadoes that come their way in the future. The main priority is coming up with a building structure that is reinforced and sturdy enough to withstand the powerful winds of a tornado. You are all engineers, and will working on this project in teams. Your job is to create and build a house, as a team, that the city of Joplin can implement in their city wide rebuild plan.

Limitations:

To complete this engineering design challenge successfully, your team must follow some important design parameters, which are:

1. You must only use the materials and resources provided (listed under at the bottom of the page)
2. You must design a house that is at least 6 inches tall, 6 inches wide, and 6 inches long.

Testing:

Your house design will be tested by undergoing the strong forces of a tornado simulation. This simulation will be a leaf blower, which will blow strong winds at your house design just like a tornado would.

Materials:

Popsicle sticks, duck tape, paper clips, card board, rubber bands, and string

Resources:

Glue, scissors, and a ruler

Deliverables:

Your engineering design team will need to submit the completed house design, the STEM Design Journal, and the Results/Reflection worksheet to the City of Joplin Board of Directors President (your teacher). Your team will also present your house design/ results to the entire City of Joplin Board of Directors (your classmates and teacher).

STEM Design Journal

ENGINEER FIRM'S NAME & TEAM MEMBERS

What problem are you solving?

Helpful Information you could use for solving this problem:

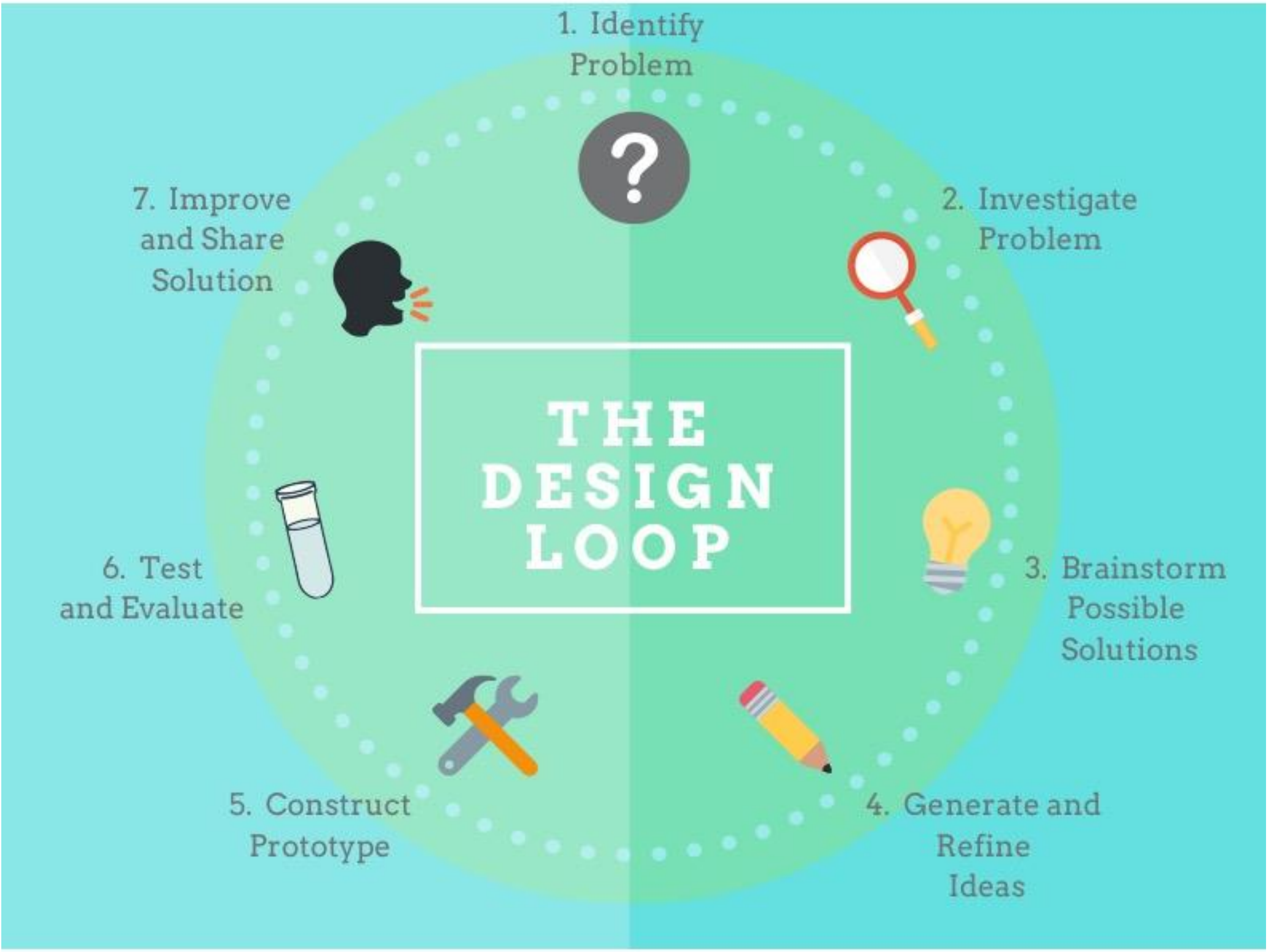
BRAINSTORM: List multiple possible solutions for this problem

GENERATE AND REFINE IDEAS: Draw 2 or 3 sketches for your house design, then circle the sketch you would like to go forward with

CONSTRUCT PROTOTYPE:
What materials will you use?

TEST AND EVALUATE:
Did you solve the problem?

IMPROVE AND SHARE SOLUTION: Can you improve your solution?


1. Identify Problem
2. Investigate Problem
3. Brainstorm Possible Solutions
4. Generate and Refine Ideas
5. Construct Prototype
6. Test and Evaluate
7. Improve and Share Solution
THE DESIGN LOOP

Time to Reflect!

MEASUREMENT REQUIREMENT:

Did your team's house design meet the measurement requirements? What were the measurements of your teams house design?

QUALITY OF HOUSE DESIGN:

Did your team's house design withstand the strong forces of a tornado (leaf blower) ?

REFLECTING ON YOUR RESULTS:

Did your team's house design hold up as well as you thought it would?

REASONING:

What is the reasoning behind your team's house design?

SHOW YOUR UNDERSTANDING:

In your own words, explain how destructive a tornado can be to a building. Go on to explain the engineering behind designing tornado proof house designs.

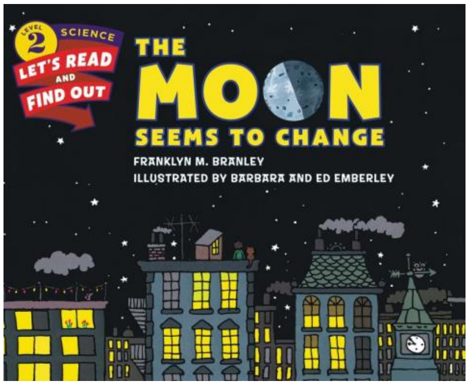
STEM Challenge

REDESIGNING THE TELESCOPE (Teacher Edition)

Submitted by: Peyton Etzel
Grade Level: 3rd

Literacy Connection: The Moon Seems to Change

by Franklyn Branley and Barbara & Ed Emberley



STEM Content Standards:
Science:
Weather and Climate

- 3-ESS2-1 Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season

Technology and Engineering:
Standard 8 – Students will develop an understanding of the attributes of design

- The design process is a purposeful method of planning practical solutions to problems
- Requirements for a design include such factors as the desired elements and feature of a product or system or the limits that are placed on the design

Mathematics:
Represent and Interpret Data

- AR.Math.Content.3.MD.B.3 Draw a scaled picture graph and a scaled bar graph to represent data with several categories

Big Ideas:

- The moon travels through different phases
- Telescopes can be used to observe the moon and its phases
- Cloud coverage can affect how you view the moon
- The engineering design process can be used to solve a variety of STEM problems

Scenario:
People have always been intrigued by the phases of the moon. Telescopes have been used for over 400 years to observe things such as the moon and the stars. While telescopes are an amazing tool, they can be fairly expensive. After doing some research, you believe that you can create an inexpensive telescope that allows you to observe the phases of the moon and how cloud coverage can alter your view. Your team will need to create a fully functioning telescope that you can use

to observe the moon for a month. You must plan your idea in the STEM design journal before you begin building.

Essential Question:
How can you create a fully-functioning telescope that you can use to observe the various phases of the moon?

Challenge:
- Create a fully-functioning telescope
- Be able to use the telescope to observe the moon's phases
- Note your observations in your journal
- Explain how cloud coverage affects your view of the phases
- Complete each step of the STEM design journal

Limitations:
- The telescope must be easy to operate
- You must be able to use the telescope to observe the moon and stars
- The telescope must be sturdy – you will be taking it home
- The telescope must be designed using the materials below
- The telescope must be presented to the other students once it is complete

Materials:
The materials available to construct the telescope are below
- Paper Towel Roll
- Pringles Can
- Foam Roll
- Saran Wrap
- Aluminum Foil
- Cardboard
- Concave Lens
- Convex Lens
- Lens Cap

Tools:
Each design team will be able to use scissors, tape, hot glue and measuring tools

Results:
- Completed STEM design journal
- Presentation of completed telescope
- Recorded observations of the moon as seen through your telescope
- Bar graph depicting cloud coverage and how it affected your view of the moon

Content Information:
As an introduction to this assignment, read *The Moon Seems to Change* aloud to the class. This book thoroughly discusses the phases of the moon and what causes them to change.

- After reading the book, discuss the moon phases in depth
  - Explain that it can be a full, quarter, gibbous, or crescent moon and that sometimes you cannot see the moon at all
  - Explain the difference between a waxing and waning moon
    - Waxing: moon is getting bigger
    - Waning: moon is getting smaller
  - Demonstrate the example from the book that explains how the phases of the moon work by using an orange, flashlight, and pencil

Next, explain to the students about cloud coverage and how it can alter their view of the moon.

- Have them perform an activity that allows them to simulate cloud coverage (Cloud Cover Learning Activity stolen from GLOBE)
  - Provide students with:
    - One sheet of light blue construction paper
    - One sheet of white construction paper divided into 10 equal segments
    - Glue stick or tape
  - Have the students choose a cloud cover percentage they want to represent in multiples of 10% (i.e. 20%, 50%, 80%)
  - Have them cut their white paper to represent the percentage they selected
    - If they chose 80%, they should cut out 80% of their white paper and recycle the remaining paper
  - Students should then slightly tear the edges of their paper to represent the clouds
  - Tape or glue the clouds onto the light blue paper
- This is a great visual for students that allows them to envision what the sky would look like with the variety of cloud coverage percentages
  - This will be important because when they are observing the moon, students will be required to estimate what percentage of the night sky is being covered by clouds and they will need to record it on a bar graph

After performing that activity, students should be familiarized with the parts of the telescope. They will be creating one, so they will need to know the most important features that should be included when building their own telescope. Such aspects include a lens, eye piece, and magnification.

Before the students start construction, they need to be introduced to the STEM design journal. Discuss how the teams can use the design process to build a successful telescope

Introduce the following vocabulary words:

- **Axis:** imaginary line about which a body rotates

- **Orbit:** a curved path around a point in space
- **Revolve:** move in a circular or curving orbit
- **Rotation:** movement or path of the earth turning on its axis
- **Tilt:** a sloping position or direction
- **New Moon:** moon is facing earth and not illuminated
- **Waxing Crescent:** right side of the moon is beginning to show in the shape of a crescent
- **First Quarter:** half of the moon is illuminated on the right side
- **Waxing Gibbous:** more than half of the moon on the right side is illuminated
- **Full Moon:** moon is facing earth and illuminated
- **Waning Gibbous:** more than half of the moon on the left side is illuminated
- **Last Quarter:** half of the moon is illuminated on the left side
- **Waning Crescent:** left side of the moon is illuminated in the shape of a crescent

Testing:
After each team has completed their design, they will prepare a short presentation. In this presentation, the students will be expected to showcase their telescopes. Other students will be allowed to look through the telescope on display to test its visibility. The students will then be able to compare their design to others and make any alterations that are necessary. Students should be reminded that modifications are a key aspect of the engineering design process.

Once the designs are finalized, students will begin doing their observations of the night sky. This will be an ongoing process that will last about a month. One student from each design group (preferably groups of four) will be assigned one week to take the telescope home. During this week, they will be expected to observe the moon 3 times. They will be expected to illustrate what the moon looks like through their telescope. Once they have a drawing, they will need to identify which phase the moon is in. In addition, they will need to record the cloud coverage. The student needs to estimate the percentage of cloud coverage then document it in a bar graph. The bar graph should be set up where the percentage of cloud coverage (in multiples of 10%) is on the y-axis and the day the data is being recorded should be on the x-axis. Once the student has recordings for all three days, they will take the average of the cloud coverage percentage and share the information with the group. The average will then be recorded on a group bar graph that breaks down the cloud coverage percentage by week. To calculate the average, students will use the following formula.

(Day 1 + Day 2 + Day 3) / 3 = Average

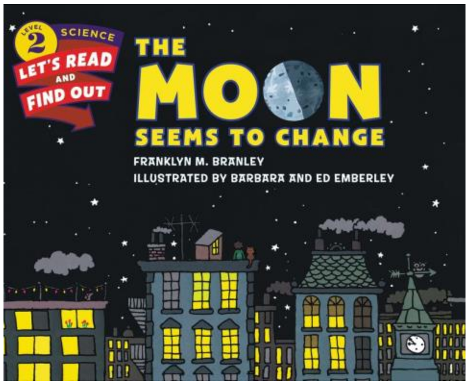
Once the experiment has concluded after approximately four weeks, students will have a completed bar graph and various illustrations of the moon from their observations. Each design group will share their findings with the class and compare answers. Students will need to submit their telescope and observations for assessment.

Teacher Evaluation:
Below is a rubric that can be used for assessment. They will be evaluated on their ability to create a telescope, identify the moon phases, and calculate cloud coverage. STEM design journals and design presentations will also be assessed.

Engineering Design Rubric

Telescope and observations were submitted along with a completed journal	/10
Student created a fully-functioning telescope that was used to observe the moon phases	/20
Students illustrated and identified the phases with the moon along with cloud coverage calculations	/20
Moon phases were accurately labeled	/20
Cloud coverage was calculated correctly and depicted through the use of bar graphs	/20
Design team presented their telescope and observations to the class in an effective and informative matter	/10
Total	**/100**
Additional Comments:	

STEM Challenge



Title: Redesigning the Telescope

Grade Level: 3rd

Literacy Connection: *The Moon Seems to Change* by Franklyn Branley and Barbara & Ed Emberley

Big Ideas:

- The moon travels through different phases
- Telescopes can be used to observe the moon and its phases
- Cloud coverage can affect how you view the moon
- The engineering design process can be used to solve a variety of STEM problems

Scenario:
People have always been intrigued by the phases of the moon. Telescopes have been used for over 400 years to observe things such as the moon and the stars. While telescopes are an amazing tool, they can be fairly expensive. After doing some research, you believe that you can create an inexpensive telescope that allows you to observe the phases of the moon and how cloud coverage can alter your view. Your team will need to create a fully functioning telescope that you can use to observe the moon for a month. You must plan your idea in the STEM design journal before you begin building.

Essential Question:
How can you create a fully-functioning telescope that you can use to observe the various phases of the moon?

Challenge:

- Create a fully-functioning telescope
- Be able to use the telescope to observe the moon's phases
- Note your observations in your journal
- Explain how cloud coverage affects your view of the phases
- Complete each step of the STEM design journal

Limitations:

- The telescope must be easy to operate
- You must be able to use the telescope to observe the moon and stars
- The telescope must be sturdy – you will be taking it home
- The telescope must be designed using the materials below
- The telescope must be presented to the other students once it is complete

Materials:
The materials available to construct the telescope are below

- Paper Towel Roll
- Pringles Can
- Foam Roll
- Saran Wrap
- Aluminum Foil
- Cardboard
- Concave Lens
- Convex Lens
- Lens Cap

Tools:
Each design team will be able to use scissors, tape, hot glue and measuring tools

Results:

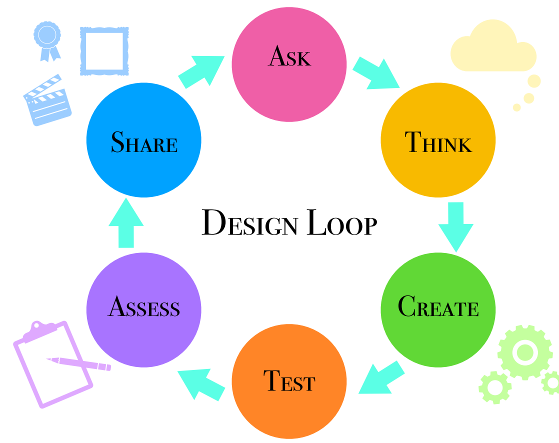
- Completed STEM design journal
- Presentation of completed telescope
- Recorded observations of the moon as seen through your telescope
- Bar graph depicting cloud coverage and how it affected your view of the moon

Stem Design Journal

Name:

Engineering Design Team Names:

What problem are you solving?



IMAGINE how you can solve this problem—Draw two or three sketches of ideas for your telescope

SELECT the best telescope idea and draw it here

CREATE your solution—What materials will you use to build your telescope?

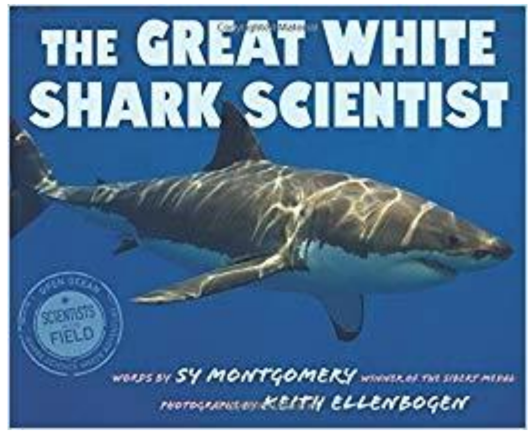
TEST your telescope.

How far can you see?

IMPROVE & SHARE: Can you improve your telescope?

What will you tell others about your telescope?

SHARK AFLOAT **(Teacher Edition)**



Submitted by: Ashley Gaboury
Grade Level: 3rd

Literacy Connection: *The Great White Shark Scientist* by Sy Montgomery

STEM Content Standards:

Science:

3-LS3-2 *Use evidence to support the explanation that traits can be influenced by the environment*

3-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.*

Technological Literacy

Standard 8: *Students will develop an understanding of the attributes of design*

3·5 Benchmarks

C. The design process is a purposeful method of planning practical solution to problems.

D. Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.

Mathematics

AR.Math.Content.3.MD.A.2 *• Measure and estimate liquid volumes and masses of objects using standard units such as: grams (g), kilograms (kg), liters (l), gallons (gal), quarts (qt), pints (pt), and cups (c)*

Big Ideas:

- *Density* helps sharks stay afloat in the water
- Sharks developed the ability to float in order to keep from sinking to the bottom of the ocean
- The shark's liver is filled with oil to keep it afloat
- The engineering design process can help people solve problems

Scenario:

Sharks are heavy animals! They can way over two tons, and grow to 20 feet long. A normal object of that size would sink to the bottom of the ocean. But sharks can stay afloat. After learning about Great White Shark scientists, you will take on the role of a shark scientist to determine how sharks can keep from sinking. Your team will construct a simple shark, and use the materials provided to create a way for your shark to float. You must plan your idea in your notebook and use the Design Process before you construct your shark.

Essential Question:

How can you make a weighted model of a shark float in a small body of water?

Challenge:

- Design and build a shark model that can float in water

- Make sure the shark doesn’t tip over to one side or the other
- Complete the Design process in your notebook
- Your final shark design must meet the limitations below

Limitations:

- The shark model must have fins that keep it balanced
- The shark model must stay afloat without being physically held
- The floating mechanism must be held inside the model
- The weight (pennies) must be added to the bottom of the shark model
- The shark model must be made using only the materials listed
- The shark model must be presented to the other teams upon completion

Materials:

The materials available to construct the shark model are below. The teacher is free to add or substitute materials as needed.

- 2 sheets of cardstock
- 1 cardboard toilet paper roll
- 3 pennies
- 1 balloon
- 1 small container of vegetable oil
- 1 small container of water

Tools:

Each design team will have the use of tape, pens and pencils, scissors, hot glue, funnels, and measuring tools.

Results (Provide these items to the teacher for assessment):

- Science Notebook
- Presentation of completed shark model
- Visual affirmation that the shark is capable of floating

Content Information:

After the lesson explain that water is less dense than oil, so it floats on top of water. A shark's liver is large and takes up a large portion of the shark's mass. Because the liver contains lots of oils, it helps the shark to float because oil is less dense than water.

If needed, you can also explain that a liver is an organ that helps "clean" the blood in your body.

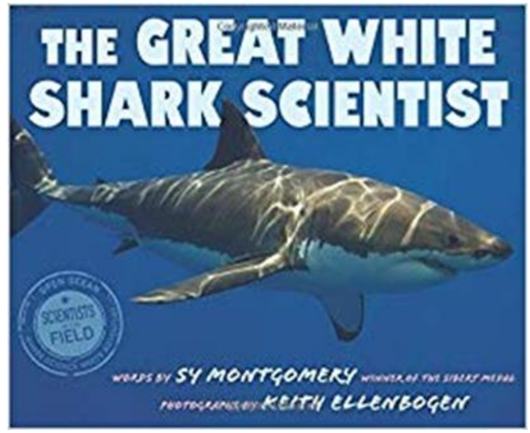
Testing:

Allow the students to visually show you how well their models perform. Did the shark float? Did it tilt to one side or the other? Ask them to note their results in their notebook. If desired results aren't achieved at first, ask students what they used to make the shark float. Question if there's maybe other things that could work instead. Allow them to change their design and note changes made in their notebooks. Teams may then present their sharks to the class after the second trial is completed. If desired, follow up with a class discussion of the experience, and allow that to lead into the explanation of why sharks float!

Teacher Evaluation: A rubric is provided below. You may also provide points for the

Shark model is submitted	/10
Shark model was created with the materials provided in an appropriate, and creative way	/20
Design team clearly and effectively presented their shark model to the class	/20
Shark model was able to float and keep balance	/20
Science notebook entry is submitted	/10
Design team followed the design process to create their shark model	/20
Total	**/100**
Additional Comments:	

completion of a shark model, the presentation of the model, and completed notebook entries.



STEM CHALLENGE

Title: Shark Afloat **(Student Edition)**

Grade Level: 3rd

Literacy Connection:

The Great White Shark Scientist by Sy Montgomery

Big Ideas:

- *Density* helps sharks stay afloat in the water
- Sharks developed the ability to float in order to keep from sinking to the bottom of the ocean
- The shark's liver is filled with oil to keep it afloat
- The engineering design process can help people solve problems

Scenario:

Sharks are heavy animals! They can way over two tons, and grow to 20 feet long. A normal object of that size would sink to the bottom of the ocean. But sharks can stay afloat. After learning about Great White Shark scientists, you will take on the role of a shark scientist to determine how sharks can keep from sinking. Your team will construct a simple shark, and use the materials provided to create a way for your shark to float. You must plan your idea in your notebook and use the Design Process before you construct your shark.

Essential Question:

How can you make a weighted model of a shark float in a small body of water?

Challenge:

- Design and build a shark model that can float in water
- Make sure the shark doesn't tip over to one side or the other
- Complete the Design process in your notebook
- Your final shark design must meet the limitations below

Limitations:

- The shark model must have fins that keep it balanced
- The shark model must stay afloat without being physically held
- The floating mechanism must be held inside the model
- The weight (pennies) must be added to the bottom of the shark model
- The shark model must be made using only the materials listed
- The shark model must be presented to the other teams upon completion

Materials:

The materials available to construct the shark model are below.

- 2 sheets of cardstock
- 1 cardboard toilet paper roll

- 3 pennies
- 1 balloon
- 1 small container of vegetable oil
- 1 small container of water

Tools:

Each design team will have the use of tape, pens and pencils, scissors, hot glue, funnels, and measuring tools.

Results (Provide these items to the teacher for assessment):

- Science Notebook
- Presentation of completed shark model
- Visual affirmation that the shark is capable of floating

STEM Notebook Entry

Your entry in your STEM notebook should contain the following:

Identify the Problem: What problem are you trying to solve?

Investigate: Is there anything you've learned before that might help you solve the problem?

Develop an Idea: What are some possible solutions? Sketch out 2-3 different solutions to the problem before you gather materials

Test your Idea: After building your model, write down your observations. Did your first trial work?

Evaluate your Idea: What worked about your first test? What didn't work? What are some ways you can improve your shark?

Present your Idea: Include a final sketch of your shark model! Feel free to name your shark! If you give your shark a name, please share it with the class when you present your final model!

Observations: Make sure you weigh your model without the floating mechanism. Weigh the model in grams (g) and include this weight in your entry. Also weigh the model with the floating mechanism, and include the weight in grams (g) in the entry. Include any other observations and notes you think are important in your journal entry.