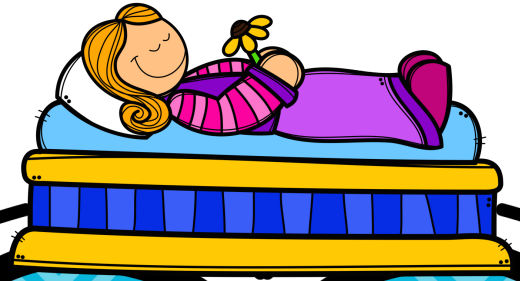
Sleeping Beauty

and

Enchanted Engineering



Teacher Notes

Sleeping Beauty and Enchanted Engineering

One way to incorporate engineering into a fairy tale is to ask students to think about what will happen after the story ends. You could actually brainstorm a list of ideas, choose which ones can incorporate engineering and let the students decide what they would like to build. This lesson, however, presents a specific scenario and engineering problem to the students

This activity is designed to allow students to apply what they know about structures.

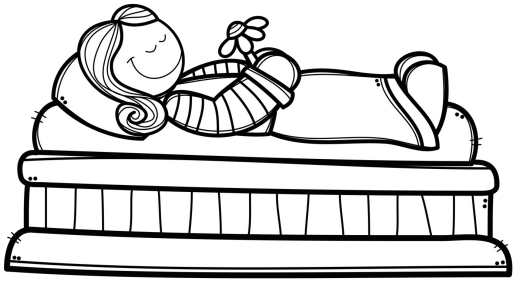
Before you begin the activity, decide on how many groups you will have and who will be in each group. We recommend that each group be composed of 3 or 4 students. Consider each of your students' strengths and weaknesses as you form groups. The dynamic within each group can dictate whether or not they are successful. Upper students could also be challenged to compute the cost of their platform bridge by assigning a cost to each card and inch of tape. As students feel that they are ready, they can test their platform bridge and measure it. If a group is successful, ask them to discuss and plan with their group members how the bridge can be improved. If the bridge is unsuccessful, encourage the team to focus on the part that isn't working. Ask them if it is a problem with how they built the bridge or is the problem with the design? Have the group go back and either work on the bridge or begin to redesign it.

The activity should begin with a class discussion of all of the requirements and constraints of the problem. Guiding questions have been provided in the design brief to make sure important concepts are emphasized. Misconceptions, constraints, and important details can be discussed.

The Challenge:

The students will develop a prototype for the platform bridge. They will use what they know about structures to build a platform bridge that can hold weight. The platform must have a height of at least 6 inches and be at least 8 inches wide. You will be awarded points as follows:

- 1 Point for each penny that the platform bridge holds
- 1 Point for every inch over 6 inches height.



Materials:

- 50 3X5 index cards
- 12 inches of masking tape
- Scissors
- Pennies
- Ruler

Sleeping Beauty and Enchanted Engineering

Calling all P.I.s …PROBLEM INVESTIGATORS!

The Prince wants to get to the castle to wake up Sleeping Beauty. He has encountered a deep river that his horse will not cross. He needs a platform bridge built quickly and knows that as an engineer, you have the skills to build a prototype for this structure. He is counting on your skills with the five P's: **problem solving, planning, perseverance, patience,** and **presentation** as you **engineer** an answer!

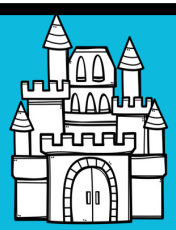
The Challenge

We need you to develop a prototype for the platform bridge. Use what you know about structures to build a platform bridge that can hold weight. The platform must have a height of at least 6 inches and be at least 8 inches wide. You will be awarded points as follows:

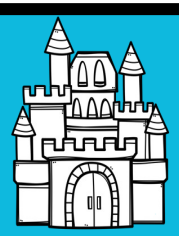
- **1 Point for each penny that the platform bridge holds**
- **1 Point for every inch over 6 inches height.**

Your materials:

- **50 3X5 index cards**
- **12 inches of masking tape**
- **Scissors**
- **Pennies**
- **Ruler**



Problem Solving



Ask:

What do you know about structures and platform bridges?

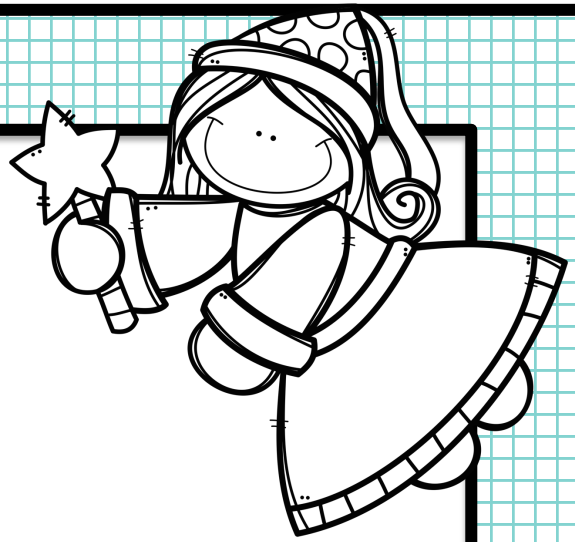
Imagine:

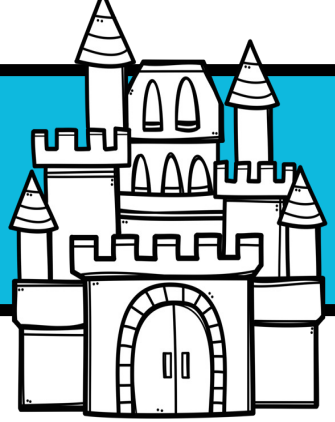
What are some ideas you can try as you design your platform bridge? How does that information help you design a platform bridge?

Planning

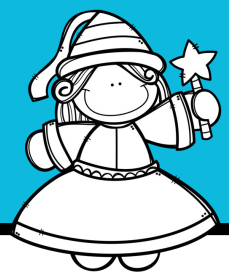
Plan : Label your steps and identify who will do each step.

2. Test your steps





Perseverance



Test

Test your platform bridge

How high is your bridge? _____

How many pennies does your bridge hold? _____

Improve

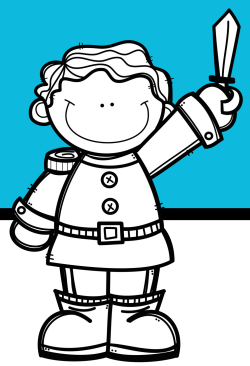
If your platform bridge did not meet your criteria, what will you change?

_____

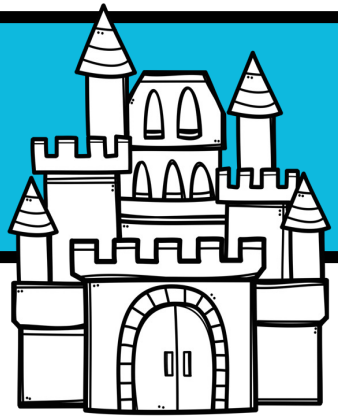
_____

_____

_____



Patience



Patience (Keep Trying!)

Test your platform bridge again.

How high is your bridge? _____

How many pennies does your bridge hold? _____

If your platform bridge does not meet your minimum criteria, what additional changes can you make to meet the criteria?

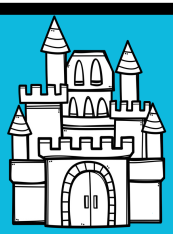
_____

_____

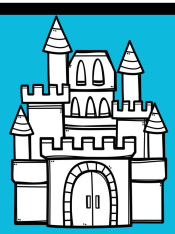
Test the platform bridge again.

How high is your bridge? _____

How many pennies does your bridge hold? _____



Presentation



Congratulations on persevering through this STEM challenge!

As you review your final product, please answer the following questions:

- What was your **plan** and why did you use this design?

_____

_____

_____

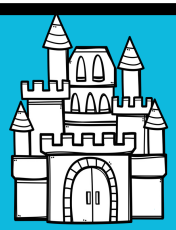
_____

- How did you solve **problems**?

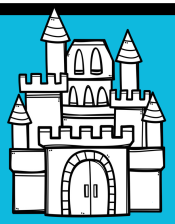
_____

_____

_____



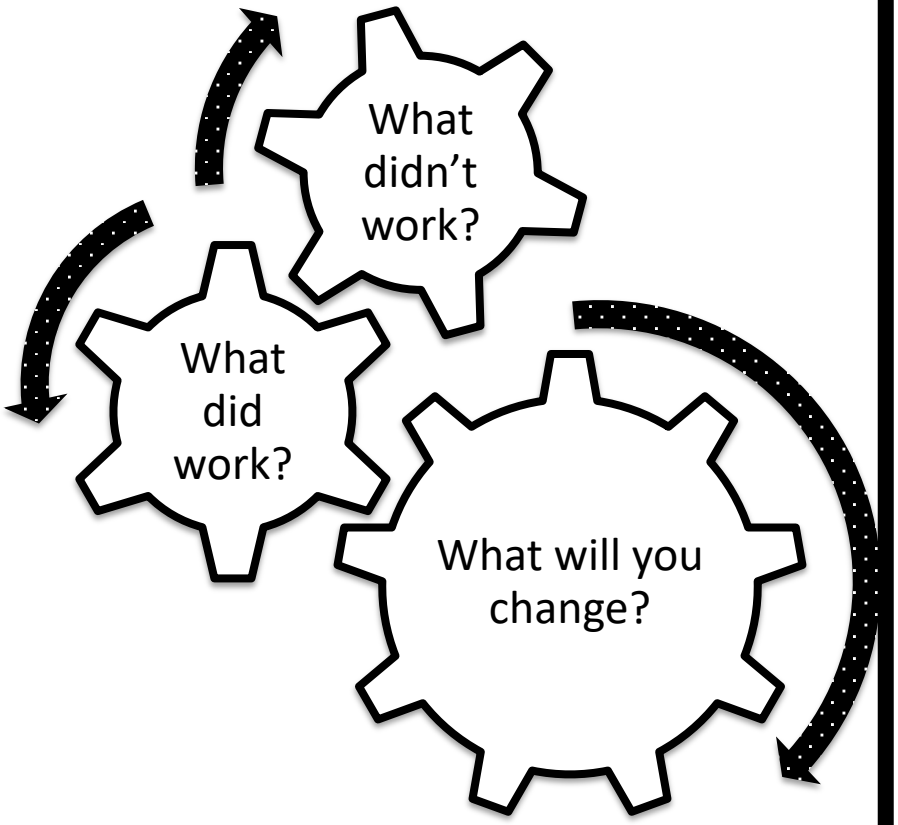
Presentation



What are some examples of how you **persevered**?

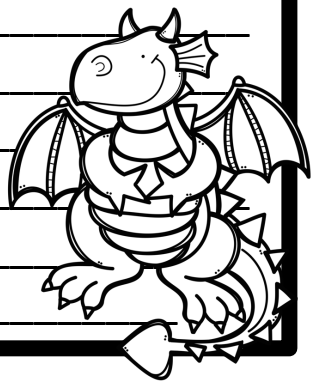
What are some examples of your **patience**?

Engineering Reflection



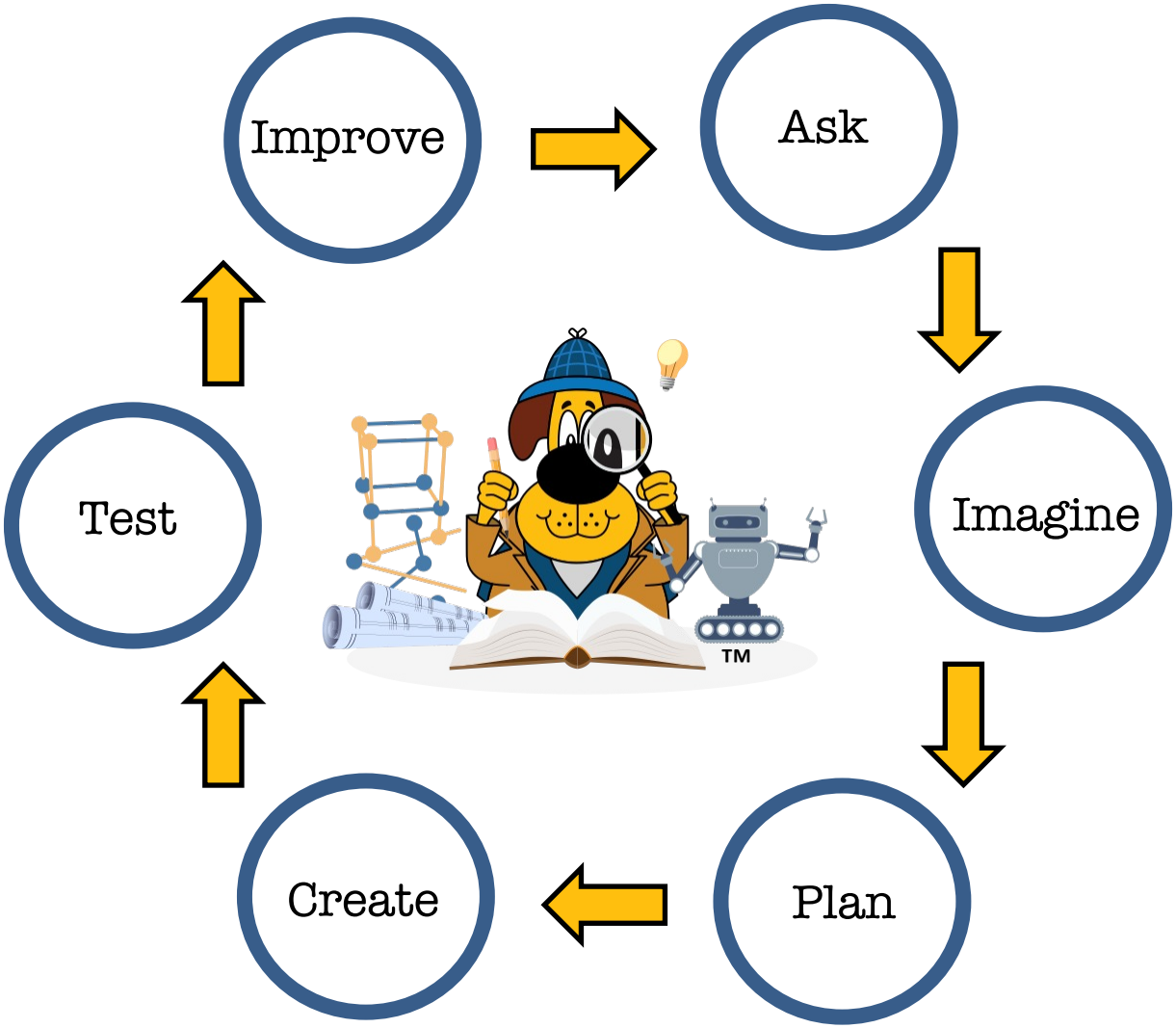
How Did You Do?

- Describe your prototype for a platform bridge.
- Look at your classmates' prototypes.
- What appears to have been good ideas to use?
- If you did this again, what would you change?



General Information and Resources

Engineering Design Process



Inquiry Questions

- What are some different things you could try?
- What would happen if you...?
- What might you try instead?
- What will you do next?
- Tell me about your materials?
- Tell me what happened?
- What does this make you think of?
- What will you do next after you finish this part?

Facilitator

- ★ Supervise and encourage participation
- ★ Have final opinion in arguments

Reporter

- ★ Record detailed notes on ideas and progress
- ★ Revise notes as needed from tests of prototype

Materials Manager

- ★ Get materials and tools for group
- ★ Supervise clean up

Presenter

- ★ Present finished work to class
- ★ Lead discussion of group's work

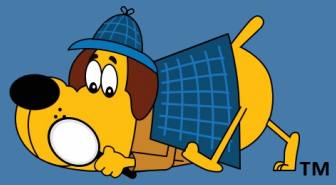
Reader

- ★ Read the problem to the group
- ★ Lead discussion of ideas

Timer

- ★ Monitor the time
- ★ Help to keep the group on task

Rubric



	No Evidence	Little Understanding	Good Understanding	Excellent Understanding
Communication **Discussed and listened to teammates' ideas and how to meet the requirements of the problem.**	**No Communication** Each person worked on their own ideas. Any exchanges with teammates tended to be arguments.	**Little Communication** Some discussion however frequent arguments. Difficulty listening to teammates ideas.	**Some Communication** Discussed ideas with only periodic arguments. Usually listened to others.	**Excellent Communication** Sustained give and take of ideas about the problem and its solution. No arguments.
Planning **Completed and discussed the problem-solving page. A detailed, labeled drawing was created.**	**No Planning** Problem-solving page not done. Skipped the sketch and went right to the creation of the prototype.	**Little Planning** Incomplete problem-solving page. An attempt at an unlabeled sketch.	**Some Planning** Both the problem-solving page and a sketch were completed. One or both is missing some details.	**Excellent Planning** Problem-solving page complete with all details. There is a labeled detailed sketch.
Perseverance **Followed agreed upon plan and collaborated to solve problems as encountered.**	**No Perseverance** Plan was ignored. Didn't complete the challenge due to giving up.	**Little Perseverance** Some parts of plan followed. Needed guidance to finish.	**Some Perseverance** Plan followed. Solved some of the problems on own and needed minimal guidance to finish.	**Excellent Perseverance** Plan completely followed. Discussed and solved problems as they arose.
Presentation **Detailed presentation outlining details, problems, and solutions.**	**No Details** Did not present	**Few Details** Very short presentation with few details.	**Some Details** Included some of the details and some of the problems and solutions encountered.	**Excellent Details** Thorough explanation of their design as well as problems and their solutions.

Introducing the Engineering Design Process

Pass out a copy of the **Get Caught Engineering®** Engineering Design Process poster so the students can refer to it throughout the activity. Tell the students that the Engineering Design Process gives engineers a framework to help them solve problems. Although the process looks like a continuous circle, most times, engineers do not make it all the way to the test step without many times going back to earlier steps.

It is suggested that this is a good time to address that the solution will not come easily and it is expected that several designs will have to be created in order to be successful. **Engineers expect to fail during the process and perceive failure as merely a step that leads them to the solution.**

"I am not discouraged, because every wrong attempt discarded is another step forward" Thomas Edison

Ask

Before engineers can plan and design a solution to a problem, they first need to totally understand the problem and know what all of the **constraints** are.

Define the word constraint and have the students compile a list of constraints for this activity. Write the list on a large piece of paper that can be posted for referral. **Encourage the students to ask questions about the requirements for successfully completing the project. In some cases, you may need to model a question that might be asked.**

Create a discussion centered around the questions in the ASK portion of the process. Younger students may need to have the questions read to them and discussed as a whole group, while older students can answer the questions independently with a follow-up class discussion before they begin.

Plan

Have individual students write and sketch their ideas and solutions. **Drawings should be detailed and labeled.**

Once each student has their ideas sketched out, they can take turns sharing their ideas with their group. This helps to insure that each student has ideas to contribute and no one student's ideas are immediately chosen. **This is a good time to emphasize that often the best solution is a blending of ideas.**

Create

Once the student has produced a detailed plan and drawing students can gather their materials and proceed. As the students create, circulate among them to evaluate how they are progressing. As they build, the students will face and need to overcome many problems. It can be frustrating for students to have repeated failures; therefore, it is recommended to end the first "creating" session with a discussion of how things are going. **Reiterate to the students that engineers fail many times before they succeed and just like real engineers, they are continually learning while they are failing.**

As you walk around you may need to help students focus on what specific parts of their design are working and what specifically is not working. In our experience some groups continually start over rather than pinpoint the flaw in their design. Help guide their thinking by using the Inquiry Questions we have included with this lesson. Encourage students that are having great difficulty creating a plan that works. **Invite them to walk around the room and look at others' designs. You may have to have a discussion with the class that this is not cheating, rather a communication of ideas.**

Test, Redesign, or Improve

Although the Design Process has a separate test stage, students should be constantly assessing if they are meeting the requirements laid out in the challenge. If students are successful, ask them to critically assess which aspects of their solution could be improved.

Reflection

It is helpful for the students to reflect on their experience once the activity is over**. Questions to ask are: What went well? What didn't work? What would you do differently next time?**

Next Generation Science Standards (NGSS)

Grades K- 2: ENGINEERING DESIGN

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

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

Grades 3-5: ENGINEERING DESIGN

3-5--ETS1-1: Define a simple design problem reflecting a need or a want that included specified criteria for success and constraints on materials, time, or cost.

3-5--ETS1-2: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5--ETS1-3: Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

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