STEM Stories: Two Bobbies
Lesson Plan

STEM Career Connections: Transportation, Distribution & Logistics Human Services, Civil Engineering, and Mechanical Engineering

STEM Disciplines: Science, Technology, Engineering, & Mathematics

Non-STEM Disciplines: English Language Arts

Design Challenge Problem/Scenario:

A recent hurricane has collapsed a bridge, which was the only way out of an island. The islanders are running out of resources quickly, and need help. Your engineering team has concluded that the best and safest option is to transport the people off the island. The water's current is currently too strong, making it an unsafe means of transportation. The only means of transportation remaining is the island's famous zip line, which includes a section leading from the island to a neighboring city.

Engineering Design Challenge:

Your team's challenge is to design and create a cradle that will safely transport one islander at a time across the zip line from the island to the neighboring city.

Essential Question Students Investigate:

How can a cradle be designed to transport one islander at a time across a zip line from the island to the neighboring city?

Enduring Understandings:

The use of collaboration and the engineering design process are both important, and help to creatively design effective solutions to problems.

English Language Arts Standards:

- RL.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- RL.3.3 Describe characters in a story (e.g., their traits, motivations, or feelings) and explain how their actions contribute to the sequence of events.
- W.3.1 Write opinion pieces on topics or texts, supporting a point of view with reasons
- SL.3.4 Report on a topic or text, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.
- SL.3.6 Speak in complete sentences when appropriate to task and situation in order to provide requested detail or clarification.

Science Standards:

Science Inquiry and Applications, Technological and Engineering Design
During the years of PreK to grade 4, all students must develop the ability to:

- Plan and conduct simple investigations
- Employ simple equipment and tools to gather data and extend the senses

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- Communicate about observations, investigations and explanations
- Review and ask questions about the observations and explanations of others
- Identify problems and potential technological/engineering solutions
- Understand the design process, role of troubleshooting

Grade 1: PHYSICAL SCIENCE: Motion and Materials
- Objects can be moved in a variety of ways, such as straight, zigzag, circular, and back and forth.

Grade 2: PHYSICAL SCIENCE: Changes in Motion
- Forces change the motion of an object.

Grade 4: PHYSICAL SCIENCE: Electricity, Heat, and Matter
- Energy can be transformed from one form to another or can be transferred from one location to another.

Mathematics Standards:
- Represent and interpret data. CCSS.MATH.CONTENT.3.MD.B.4 Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units--whole numbers, halves, or quarters.
- Use place value understanding and properties of operations to perform multi-digit arithmetic. CCSS.MATH.CONTENT.3.NBT.A.2 Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.
- Use place value understanding and properties of operations to perform multi-digit arithmetic. CCSS.MATH.CONTENT.3.NBT.A.2 Multiply one-digit whole numbers by multiplies of 10 in the range 10-90 (e.g., 9 x 80, 5 x 60) using strategies based on place value and properties of operations.
- Represent and solve problems involving multiplication and division. CCSS.MATH.CONTENT.3.OA.A.1 Interpret products of whole numbers, e.g., interpret 5 x 7 as the total number of objects in 5 groups of 7 objects each.
- Represent and solve problems involving multiplication and division. CCSS.MATH.CONTENT.3.OA.A.1 Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem.
- Multiply and divide within 100. CCSS.MATH.CONTENT.3.OA.C.7 Fluently multiply and divide within 100, using strategies such as the relationship between multiplication and division (e.g., knowing that 8 x 5 = 40, one knows 40 ÷ 5 = 8) or properties of operations. By the end of Grade 3, know from memory all products of two one-digit numbers.

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Materials List:

Material	Quantity per Team	✓
Straws	5	
Masking Tape	3 in	
String *(for team designs & for 1 zip line used to test designs)*	1 foot *(per team)* 4 feet *(for zip line)*	
Toothpicks	8	
Duct Tape	2 inch	
Paperclips	3	
Pipe Cleaners	2	
Wooden Craft Sticks	4	
Ribbon	5 inches	
Rubber Bands	5	
Cups	1	
Lego People	1	
Scissors *(to cut duct tape)*	~	
PowerPoint	~	
Pre-Activity Survey	~	
Post-Activity Survey	~	
Cardstock	1 sheet	
Handouts	~	

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Activity 1

Introduction: 5 minutes

Sit in a chair and gather the students on the floor around you so they can all see the book.

Describe the full scope of the Engineering Challenge (Activity 1, Activity 2, Activity 3, etc.).

Introduce *Two Bobbies* by Kirby Larson and Mary Netherly by reading the title and author and examining the cover illustration.

Show short video clips from YouTube of hurricanes to build background knowledge.

- https://www.youtube.com/watch?v=dA5qYrboTUE
- https://www.youtube.com/watch?v=sB21YD-S_b0&t=121s

Pre-Reading: 10 minutes

Lead a pre-reading discussion by asking the following questions of the students:

- Predict: What might the book be about? Where do you think the story takes place?
- Read the book jacket summary aloud. Ask, What are some questions you have before reading this book? What would you like to find out by reading this book?
- Read the title page. What is the setting of the story? **Share the map of the United States** and point out Louisiana and New Orleans.

Read Aloud: 20 minutes

Read the book aloud to the class, making sure to share the illustrations on each page. Stop periodically to ask the students to share what they are learning about the animals and their situation.

Throughout the read-aloud, you can use the following strategies to monitor the students' comprehension of the story:

- Maintain a T-chart throughout the read aloud to record the differences between the cat and the dog and the ways they help each other.
- Ask students a question about the story, then ask them to "turn and talk" to their neighbor to answer the question. Be sure to set a signal for when students should stop their conversation and come back to the large group (hand clapping, snapping, etc.). Questions you might ask include:
    - What do you know about the setting of the story?
    - How do you know this is a true story? What clues let you know it is true?
    - What acts of kindness are happening in the story?
    - How long did the owners of the pets expect to be gone? What clues in the story help you know this?
    - Why do you think Bob Cat stayed with Bobbi? What details from the story help you know this?
    - What is the relationship between Bob Cat and Bobbi? What details from the story help you know this?
    - Why would it take a very special family to adopt the Bobbies?

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- Why do you think Bobbi wouldn't let anyone near Bob Cat?

Post Reading: 15 minutes

Discuss what is meant by "devastation". Ask the students to brainstorm what the word means, then provide the definition:

- Pronounce the word and have students repeat
- Tap the word into syllables (dev-a-sta-tion) and have students repeat
- **Devastation means something is badly or completely damaged.**
- Provide examples and non-examples of devastation

Example: In *Two Bobbies*, devastation means damaged and dangerous. The city of New Orleans was damaged and dangerous for people to inhabit, causing them to abandon their homes.

Non-Example: Spilling your milk at lunchtime, does that show devastation?

- Check for understanding. Give me a thumbs up or thumbs down if these are examples of devastation:
    - If there is a light rain during recess, is that an example of devastation? (No)
    - If strong winds tear down trees in your neighborhood, is that an example of devastation? (Yes)

Distribute the Circle Chart and the examples and non-examples of devastation (copies of illustrations from the book and other photos). Ask students to work in pairs to paste the pictures of devastation onto the Circle Chart. Share some as a large group.

*This chart can be pasted into the STEM journal as a way to keep track of the student's learning throughout the modules. Paste it in before or after the Quick Write (next activity).

Wrap Up: 5 minutes

Review what was learned during today's session.

- Invite a retelling of the book by asking students to share what happened first, second, third, and so on in the story.
- Review the concepts of how the animals helped each other and the important vocabulary word, devastation.
- Preview next session for students will be the Engineering Design Challenge.

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Activity 2

Introduction: 10 minutes

- Remind the students that during the previous session they read and discussed the book *Two Bobbies* by Kirby Larson and Mary Netherly. Do a "picture walk" through the book to remind students of the main idea (stopping to ask students about the text and reminding them what happened).
- Explain that today students will be presented with a Design Challenge Problem and Engineering Design Challenge that relates to the story; so, it is important that students understand the book.
- Lead into a quick write about the book.

Quick Write: 15 minutes

Distribute the STEM journals to the students (composition notebooks). Direct them to write their name on the front cover of the book, then turn to the next page of the book (the first page will become a table of contents for the journal). Ask them to write the date at the top of the page, and *Entry #x: Two Bobbies*.

Ask them to respond to one of the following writing prompts in their journal (teacher should select one ahead of time). Students can respond in writing, illustrations, or both.

- Using evidence from the text, describe how volunteers in the community helped the two Bobbies find a permanent home. Use words or pictures.
- Describe the relationship between the two Bobbies. How do they become friends and how do they help each other?
- What does it mean to be a good friend?

Set a timer for 10 minutes and ask the students to write for the full ten minutes. Tell them to keep their pen moving the whole time, even if they are illustrating their response.

When the ten minutes are up, invite the students to find a partner (or you can identify the partners) to share their writing. Then, invite the students to the large group and ask students to share their responses if they wish (and as time allows).

Application: 20 minutes

- Display slide one of the PowerPoint: Ask the students to share some ideas about what engineers do for their jobs.
- Slides 2 & 3: Continue the discussion about what engineers do for their jobs.
- Slides 4: Show Zipline Rescues from Mexico Floods video –
  NOTE: Video must be ended abruptly at 1m14s.
- Slide 5: Present the Design Challenge Problem.
  - Design Challenge Problem/Scenario:

    A recent hurricane has collapsed a bridge, which was the only way out of an island. The islanders are running out of resources quickly and need help. Your engineering team has concluded that the best and safest option is to transport the people off the island. The water's

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current is currently too strong; therefore, boats cannot be used to transport people off of the island. The only means of transportation remaining is the island's famous zip line, which includes a section leading from the island to a neighboring city.

- Slide 6: Present the Engineering Design Challenge.
    - Engineering Design Challenge:

      Your team's challenge is to design and create a cradle that will safely transport one islander at a time across the zip line from the island to the neighboring city.
- Slide 7: Explain the Design Goals.
    - Your team of engineers will design cradle that holds and transports islanders along a zip line and off the island.
    - Your design must cradle and transport one LEGO person at a time to safety.
    - Only materials supplied to your may be used.
    - Hold your design at the top of the zip line, force its potential energy to transform to kinetic energy by giving it a push.
    - You may not help your design complete its movement across the zip line.
    - Have fun!!
- Slide 8: Introduce the resources/materials available.
    - You will have: straws, masking tape, string/yarn, toothpicks, duct tape, paper clips, pipe cleaners, wooden craft sticks, ribbon, rubber bands, and cups.
- Slide 9: Explain the design testing procedures.
    - The cradle must hold one LEGO person.
    - Only one push from the top may be used to begin the cradle's motion.
- Slide 10: Explain the Engineering Design Process.
    - Distribute the Two Bobbies: Engineering Design Process Graphic Organizer STEM Challenge handout and Engineering Design student handout.
- Slide 11: Have the students complete the "Ask" step of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
    - Ask the students to notice the word Ask in one of the circles of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
    - Students should Ask themselves what materials they would like to create a cradle that will safely transport one islander at a time across the zip line from the island to the neighboring city.
    - Students should write these materials on their STEM Challenge handout.
    - Walk around as the students complete the Ask step of the Engineering Design Process.
- Slide 12: Explain to the students that the next time they meet, they will spend time on the Imagine step in the Engineering Design Process. In fact, you can ask students to start imagining what their product will look like when they are at home, and they can share their ideas with their families.

Wrap Up: 10 minutes

- Review what was learned during today's session.
- Remind the students of the Engineering Design Challenge.

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- Ask if they are excited about the challenge. What excites them?
- What do they think will be the most difficult part of the challenge?
- How might they be able to work through that?

- Preview the next session by explaining to students that they will be working with the materials in the kit to create their prototype.
- Distribute the parent letter to each student.

Activity 3

Introduction: 5 minutes

- Remind the students that during the previous session they were presented with a Design Challenge Problem/Scenario and Engineering Design Challenge. Generate a discussion about the Design Challenge Problem and Engineering Design Challenge. Ask students how they think this design challenge relates to the *Two Bobbies* book.

Engineering Design Process, Imagine: 10 minutes

- Display slide 12 of the PowerPoint:
  - Ask the students to notice that the word Imagine is in one of the circles of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
  - Students should Imagine what their cradle will look like. Reiterate that the cradle must safely transport one islander at a time across the zip line from the island to the neighboring city. The cradle will start at the top of the zip line and get only one push. The cradle should make it to the bottom of the zip line, holding one LEGO person.
  - Students should draw a picture or write a description of their cradle on their STEM Challenge handout.
  - Walk around as the students complete the Imagine step of the Engineering Design Process.
- Slide 13:
  - Ask the students to share their ideas with their team.
  - Walk around as the students share their ideas with their teammates. Make sure that each student is given ample time to share his or her ideas. Students get excited about wanting to create their cradle and often rush through the sharing process. Remind students that the sharing process is extremely important as engineers often alter their designs based on ideas shared during the brainstorming process.

Engineering Design Process, Plan: 20 minutes

- Slide 14:
  - Ask the students to notice that the word Plan is in one of the circles of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
  - Students should Plan as a team what their cradle will look like.
  - Students can use a teammates' ideas or a combination of the teams' ideas, but remind them that they must create one cradle together as a team!

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- Students should draw a picture or write a description of their cradle on their STEM Challenge handout.
- Walk around as the students complete the Plan step of the Engineering Design Process.
- Make sure all students are contributing to the planning process. Often the dominant students expect the other students to use his or her ideas. Remind students that coming to a team consensus is important as engineers are often expected to plan with a group of people.
- Ask students probing questions about their cradle:
  - How did you combine your individual design ideas?
  - Why did you choose that design?
  - How did you create the idea for this design?
  - What are your reasons for selecting the material for your cradle?
- Before allowing teams to create their cradle, require them to gain approval of their sketch of the team's prototype design idea. You can write "Approved" beside the sketch on a student's paper or hand them a note card with "approved" written on it. A colored note card works nicely as you can easily see if a team has the note card on their desk or table before they begin to work with the materials.

Calculate Cost of Materials: 15 minutes

- Slide 15: Student will use the Two Bobbies: Cost of Materials handout and calculate the cost of a few materials. Walk around as the students discuss how to calculate the cost of the glue. Allow students to use any strategy to calculate the unit price. Listen to students share their strategies so that you can ask these students to share their strategies during share time.
  - If four styrofoam cups cost $1.00, what is the cost of one styrofoam cup?
  - If six rubber bands cost $0.90, what is the cost of one rubber band?
  - If two paper clips cost $0.30, what is the cost of one paper clip?

Share Time: 5 to 10 minutes

- Students share how they calculated the cost of one styrofoam cup, one rubber band, and one paper clip.

Wrap Up: 5 minutes

- Ask students to place their handouts and materials in a safe location and to clean up their area.
- Distribute the parent letter to each student.

Activity 4

Introduction: 5-10 minutes

- Show the students the book *Two Bobbies* by Kirby Larson and Mary Netherly, and ask them to raise their hands and offer a one-sentence summary of the book. Invite as many one-sentence summaries as time allows. Alternatively, ask the students to turn to a partner and tell a one-sentence summary of the book.
- Help teams of students locate their handouts and materials.

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- Remind the students that during the previous session they calculated the cost of some materials.
- Today, students are going to purchase materials and create their cradle.

Buying Time!: 15 minutes

- Students work as a team to decide what materials they want to purchase to create a cradle. The materials are on slide 15 of the PowerPoint and on the Two Bobbies: Buying Time! handout. Students should use the table in the handout to record the number of each item they want to purchase, the cost associated with each item, and the total cost of all items.
- Walk around the room as the students discuss the materials they would like to purchase.
- Once a team is ready to purchase their materials, have them tell you the cost of the materials they would like to purchase and the change they should receive.

Teams Create Their Cradles: 30 minutes

- Slide 16: Ask the students to notice that the word Create is in one of the circles of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
- Remind students of the Design Goals:
    - Create a cradle that will hold one LEGO person.
    - Create a cradle that will slide from the top to the bottom of the zip line with only one push.
    - Use only the materials that are available.
    - Create a cradle in the given time.
    - Create a cradle on wax paper.
- Students should draw a picture on the STEM Challenge handout of the cradle they plan to create.
- Students should create their cradles. As the students are creating their cradles, walk around the room and ask them probing questions about their design. For example:
    - What are your reasons for selecting that material?
    - What are your reasons for using that material for your cradle?

Wrap Up: 5 minutes

- Ask students to place their cradles in a safe location and clean up their area.
- Ask the students if they have any ideas as to what type of engineer might design cradles to rescue people.

Activity 5

Prior Set-up:

Setup the zip line so that it is:

- On a steep slope
- 3 - 4 feet in length
- Taut, with no slacking or sagging

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Test the zip line's length and slope; making sure it is efficient for student's to test their cradles.

Make sure there is room for all students to observe the zip lines.

Introduction: 5 minutes

- Help teams of students locate their handouts and materials.
- Remind the students that during the previous session they created a cradle.
- Today, students are going to test their cradle.

Prototype Testing: 30 minutes

- Slide 17: Each team tests their prototype cradle design while other teams observe.
    - The cradle must hold one LEGO person.
    - Only one push from the top may be used to begin a cradle's motion.
    - If a team's design passes, they may modify their existing design or reconstruct a new one, if time permits. Consider adding additional constraints (such as not using a material that was used in the initial design, adding costs to items, transporting more LEGO people, etc.).
    - If a team's design fails, they may redesign and test again, if time permits.
    - Celebrate each team's design by having the class applaud for that team after that team shares their design.

Reflection: 10 minutes

- Slide 18: Ask students to discuss with their team:
    - What do you like best about your cradle?
    - What would change about your cradle?
    - What aspects of other team designs stood out to you?
    - Did other designs give you ideas for ways to improve your design?
    - What modifications would you make if we had time to complete the design challenge again?
    - How did the materials affect the ability for your cradle to slide along the zip line?
    - How did the slope of your zip line affect the ability for your cradle to slide along the zip line?
    - How did transformations between potential energy and kinetic energy force your design to move along the zip line?
    - What role did friction play on the safety and speed of your design as people were transported along the zip line?
- Students should complete the Two Bobbies: Test and Improve Your Cradle handout.
- If time permits, ask some students to share their ideas with the entire class.
- Ask the students if they have any ideas as to what type of engineer might create a cradle that will safely transport one islander at a time across a zip line from the island to the neighboring city.

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Wrap Up: 5 minutes

- Ask students to place their cradles in a safe location and clean up their area.
- Distribute the parent letter to each student.

Activity 6

Introduction: 5 minutes

- Help teams of students locate their handouts and materials.
- Remind the students that during the previous session they tested their cradles.
- Today, students are going to reflect on how they can improve their cradles.

Engineering Design Process, Improve: 5 minutes

- Slide 19: Ask the students to notice that the word Improve is in one of the circles of the Engineering Design Process both on the PowerPoint and the Two Bobbies: Engineering Design student handout.
- Students should discuss how they can Improve their cradle.
- Students can use a teammates' ideas or a combination of the teams' ideas, but remind them that they must create one cradle together as a team!
- Students should draw a picture or write a description of their cradle on their STEM Challenge handout.

Teams Create a Cradle: 30 minutes

- Slide 20: Ask the students to notice that the word Improve is in one of the circles of the Engineering Design Process.
- Instruct students to create their improved cradle on the wax paper.
- As the students are creating their improved cradles, walk around the room and ask them probing questions about their design. For example:
    - What are your reasons for selecting that material?

Wrap Up: 10 minutes

- Ask students to place their handouts and materials in a safe location and to clean up their area.
- Ask students why they think it is important for them to make a second prototype.
- Ask them what is one thing they changed in their design (turn and talk, then have one or two students share whole group).
- Preview next lesson by saying that tomorrow they will test their improved designs and reflect on the project as a whole.

Activity 7

Introduction: 5 minutes

- Help teams of students locate their handouts and materials.
- Remind the students that during the previous session they created an improved cradle.
- Today, students are going to test their improved cradle.

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Prototype Testing: 20 minutes

- Slide 21: Each team tests their prototype cradle while other teams observe.
    - The cradle must hold one LEGO person.
    - Only one push from the top may be used to begin a cradle's motion
    - Celebrate each team's design by having the class applaud for that team after that team shares their design.

Reflection: 10-15 minutes

- Slide 22: Ask students to discuss with their team:
    - What do you like best about your cradle?
    - What would change about your cradle?
    - What aspects of other team designs stood out to you?
    - Did other designs give you ideas for ways to improve your design?
    - What modifications would you make if we had time to complete the design challenge again?
    - How did the materials affect the ability for the cradle to slide along the zip line?
- If time permits, ask some students to share their ideas with the entire class.
- Ask the students if they have any ideas as to what type of engineer might design a cradle.

Wrap Up: 20 minutes

- Discuss text-to-self, text-to-text and text-to-world connections with the students. Put the Text Connections handout on the overhead or Elmo machine so all students can see it and explain each type of connection.
- Read the story, *Two Bobbies* again. As you read, ask the students to make text-to-self, text-to-text or text-to-world connections between what they hear in the story and the STEM challenge. Ask them to keep track of their connections using tally marks for each connection on a blank copy of the handout, which can be pasted into the STEM journal as an additional entry.
- Stop periodically throughout the story to share your own connections as a model, then invite students to share their connections. Remind them of the importance of using "textual evidence" to make their connections. Ask, "What sentence or picture in the story helped you make that connection?".
- (Optional Writing Activity) Ask the students to write a one paragraph summary of their connections to the book and the STEM challenge.
- Slide 23: Conclude by discussing the following questions as post-activity surveys are distributed.
    - What ideas do you have for engineering a better world?
    - How can you turn ideas into reality?
- Allow time for students to complete their post-activity survey.
- Distribute the parent letter to each student.

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Additional Notes:

Whether the design works or not, ask what modifications could be made in order to improve its effectiveness.

Be sure students understand that failure is normal in engineering, which is why engineers use readily available, cost-effective materials when initially designing and testing a prototype idea. True failure occurs only when the designer is not persistent in brainstorming ways to improve their design.

- Start with only one push from the top of the zip line
- Ensure the zip line has a steep slope
- Design must make it to the bottom of the zip line, holding LEGO person throughout.

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