STEM Stories: The Airport Book
Lesson Plan

STEM Career Connections: Civil Engineering, Mechanical Engineering, Architecture and Construction

STEM Disciplines: Science, Technology, Engineering and Mathematics

Non-STEM Disciplines: English Language Arts

Design Challenge Problem/Scenario:

You work as a line crew member (a person that loads and unloads luggage) for an airline company. Because unloading luggage from an airplane by hand is time consuming and inefficient, you decide to try and come up with a better luggage transport system.

Engineering Design Challenge:

Your challenge is to design a more efficient system for transporting luggage straight from the airplane to the conveyor belt where passengers pick up their belongings. Your design must transfer marbles from an elevated cup (symbolizing the airplane) to a cup on a lower level (symbolizing the baggage claim area). You may use only the provided materials.

Essential Question Students Investigate:

How do we create a ramp that can quickly and efficiently transfer luggage from an airplane to a conveyor belt?

Enduring Understandings:

- Using the engineering design process when approaching problems results in unique solutions.
- Collaboration and following the engineering design process lead to more creative and effective solutions to problems.
- All energy can be put into two categories: kinetic and potential; each form can be transferred to another place or object. An object in motion has kinetic energy. Energy in an object that is “waiting” to happen (to be put into motion) is the object’s potential energy.

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.

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- 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
- 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 multiples 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

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operations. By the end of Grade 3, know from memory all products of two one-digit numbers.

Materials List:

Material	Quantity per Team	✓	Quantity per Kit	✓
Craft Sticks	**4**		**60**	
Paper Towel Roll Halves	**1**		**15**	
Construction Paper	**1 sheet**		**1 pack**	
Straws	**6**		**80**	
String	**1 yard**		**1 ball**	
Tape	**6 inches**		**80 inches**	
Index Cards	**6**		**80**	
Marbles (for testing)	**~**		**10**	
Styrofoam Cups (for testing)	**~**		**4**	
PowerPoint	**~**		**1**	
Pre-Activity Survey	**~**		**25 copies**	
Post-Activity Survey	**~**		**25 copies**	
Post-it Notes OR Paper *(For individual brainstorming)*	**15 Post-its OR 3 sheets paper**		**2 packs Post-its OR 25 sheets paper**	
Paper *(For team design sketch)*	**1 sheet**		**15 sheets**	

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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 *The Airport Book* by Lisa Brown by reading the title and author and examining the cover illustration.

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? What experiences do you have with airplanes, airports, or taking a trip.
- Read the book jacket summary aloud. Ask, Describe what happens at an airport. Try to have the students discuss what happens to your luggage at the airport (it goes on the conveyor belt).
- Read the endpapers with the students (the inside front and back covers of the book). What is happening at the beginning of the book? What is happening at the end? Why did it change? Which place would you rather spend a week?
- What are some questions you have before reading this book? What do you think the Engineering Design Challenge might be related to this book?

Read Aloud: 20 minutes

Read the book aloud to the class two times. The first time, do not show the students any of the illustrations, other than the cover. Read the typed text only. Ask the students to retell the story to a partner in a "turn-and-talk" style, then have a student volunteer share the retelling.

The second time you read the story, share the illustrations, and make sure to stop on the title page to read the quotations and look at the illustrations. This book is very interactive, so be sure to "read" the illustrations as well as the typed text. Draw the student's attention to the monkey throughout the book.

- Questions you might ask as you read the story the second time include:
  - Why does the ground have to be flat where an airport is?
  - Look at the different types of bags on pages 3 and 4. What might make them easy or difficult to carry on a plane? Point out the luggage conveyor belt that begins on pages 5 and 6 and continues throughout the story. You can do this by looking for Monkey's tail!
  - On pages 11and 12 and 13 and 14, be sure to point out the ramp putting the luggage onto the plane, into the holding area.
  - On pages 23 and 24, the ramp takes the luggage off the plane. Follow monkey to see how he gets on and off the plane on these ramps!
  - There are a lot of things happening in all of the illustrations, so invite the students to contribute their observations to the page, and point out the small details to the students.

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Post Reading: 15 minutes

Reading the book twice in this manner will help the students understand the concept of Close Reading (Beers & Probst, 2013). Close reading is a strategy in which we pay close, careful attention to the text to make connections, discuss it with other readers, and to the elements of the story itself. In The Airport Book, the reader should pay close, careful attention to the book to be able to understand all of the elements of the story. Ask the students to share their reactions to the two different experiences of reading the story. Which one did you enjoy more? Which one gave you more information? Why? Ask them to describe what it means to read closely in their own words.

Distribute the Close Reading chart, and ask the students to complete the chart on their own. When they are finished, they can share their answers quietly with a partner, then debrief as a large group. Focus the students on the different information they were able to learn by reading closely as opposed to only reading the text once.

*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 (below).

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 close reading and why it can help us understand more of what we are reading.
- Preview next session and tell the students they will be learning about the Engineering Design Challenge.

Activity 2

Introduction: 10 minutes

- Picture walk through the book and ask students to describe what happens throughout the story → make sure students understand the main idea.
- Relate the story to the Design Challenge Problem:
    - "In this story we learned all about being at an airport and for our design challenge we are going to think of a good way to load and unload the luggage onto the airplane. We will learn more about this later."
- Move to STEM journal entry.

Quick Write: 15 minutes

Distribute the STEM journals to the students (composition notebooks). Direct them to turn to the next blank page in their notebooks. Ask them to write the date at the top of the page, and *Entry #X: The Airport Book*.

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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.

- Imagine you are packing a bag for a trip. Where would you go? What would you pack? Why? What would you do once you arrive at your destination?
- The little girl in this story made certain to pack her stuffed monkey for the trip. If you were the main character in this book, what would be the special item in your suitcase? Why?
- Write about an adventure your special item might have as it travels through the airport, just as monkey had an adventure with the dog.

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 is over, 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 & 5: Present the Design Challenge Problem.
    - Design Challenge Problem: You work as a line crew member (a person that loads and unloads luggage) for an airline company. Because unloading luggage from an airplane by hand is time consuming and inefficient, you decide to try and come up with a better luggage transport system.
- Slide 6: Present the Engineering Design Challenge.
    - Engineering Design Challenge: Your challenge is to design a more efficient system for transporting luggage straight from the airplane to the conveyor belt where passengers pick up their belongings. Your design must transfer marbles from an elevated cup (symbolizing the airplane) to a cup on a lower level (symbolizing the baggage claim area). You may use only the provided materials. The marble ramp that you design will need to be free-standing. The marble ramp should work without being held by you as the marbles roll down it.
- Slide 7: Explain or share the Design Goals.
    - Design and create a ramp to move the marbles from the top cup (airplane) to the bottom cup (luggage rack).
    - Use only materials provided.
    - Don’t let marbles fall off of your design.
    - Transport all the marbles.
    - Have fun!!
- Slide 8: Introduce the resources/materials available.

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- Slide 9: Explain the design testing procedures.
    - One cup full of marbles will be elevated (airplane) and there will be another cup at a lower level (luggage rack).
    - You have to get the marbles from the top cup (airplane) to the bottom cup (luggage rack) using your design.
    - Each team may have 3 trials.
- Slide 10: Explain the Engineering Design Process.
- Slide 11: Have the students complete the "Ask" step of the Engineering Design Process.
    - Give students the Engineering Design Process Graphic Organizer STEM Challenge handout and The Airport Book: Engineering Design student handout.
    - Ask the students to notice that the word Ask is in one of the circles of the Engineering Design Process both on the PowerPoint and on The Airport Book: Engineering Design student handout.
    - Students should Ask themselves what materials they would like to use to create their marble ramp.
    - 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 11: 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.

- Invite a retelling of the book by asking students to share what happened first, second, third, and so on in the story.
- Remind the students of the Engineering Design Challenge.
- Preview the next session by explaining to students that they will continue the Engineering Design Process so that they can imagine and plan to create their marble ramps.
- Distribute the parent letter to each student.

Activity 3

Set-Up:

- Pick an open table in the room and set up a cup on its side full of marbles to symbolize the airplane. Make sure this upper area is elevated so that it gives room for the ramps. Two possible options for this are a cup on top of a stack of books with a cup on a desk or use a desktop for the upper height and a chair for the lower height so that you may set up more than one easily.

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- Place an empty cup at the end goal so the students know how far their ramp needs to stretch to deliver the marbles. (See photo of set up on Design Testing slide of PowerPoint.)
- Designate space for displaying and gathering available materials.
- Designate space for each team to collaborate and create their design ideas. Also, make sure all students will be able to see the presentation.
- Designate space for design testing. Make sure there is room for all students to observe.

Introduction: 5 minutes

- Remind the students that during the previous session they read and discussed *The Airport Book* by Lisa Brown and were presented with a Design Challenge Problem and Engineering Design Challenge. Generate a discussion about the Design Challenge Problem and Engineering Design Challenge.

Engineering Design Process, Imagine: 15 minutes

- Display slide 11 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 on The Airport Book: Engineering Design student handout.
    - Students should Imagine what their Marble Ramp will look like.
    - Students should draw a picture or write a description of their Marble Ramp on their STEM Challenge handout.
    - Walk around as the students complete the Imagine step of the Engineering Design Process.
    - 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 a marble ramp 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: 15 minutes

- Display slide 11 of the PowerPoint:
    - 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 on The Airport Book: Engineering Design student handout.
    - Students should Plan as a team what their marble ramp will look like.
    - Students can use a teammates' ideas or a combination of the teams' ideas, but remind them that they must create one marble ramp together as a team!
    - Students should draw a picture or write a description of their marble ramp 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

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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 the students probing questions about their marble ramp designs:
        - 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 marble ramp?
        - Suppose a company decided to use your team's ideas for an actual luggage ramp they plan to create. How sturdy do you think their marble ramp will be?
    - Before allowing teams to create their marble ramps, 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.

Buying Time!: 15 minutes

- Students work as a team to decide what materials they want to purchase to create a marble ramp. The materials are on the The Airport Book: 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.

Engineering Design Process, Create: 30 minutes

- Slide 11: Teams create their marble ramps
    - 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 on The Airport Book: Engineering Design student handout.
    - As the students are creating their marble ramps, walk around the room and ask them probing questions about their design. For example:
        - Why did you choose those materials for the design?
        - Will the design be stable as the marbles roll down it?
        - Will the marbles fall off the sides as they roll down?

Prototype Building - Notes

When the students create the marble ramp prototype, they are to use the materials given and the time allotted. They need to create a ramp that can move the marbles from one place to another without the marbles falling off the ramp. The students'

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designs cannot be connected in any way to either of the cups or the surface where the cups are. For older students, put a price tag on the items and only give them a certain budget that they cannot exceed. You could also place the two cups farther apart or with a larger incline between them so their designs have to go farther to accomplish the task.

Informal Testing: 5 minutes (Optional)

- Slide 11:
    - 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 on The Airport Book: Engineering Design student handout.
    - Tell the students that the official testing of the marble ramps will take place next time, but that they can have one marble to test their designs.

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: 10 minutes

- Show the students the book, *The Airport Book*, 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. Remind students that they are working on creating a ramp to move luggage from an airplane to a luggage rack.
- Help teams of students locate their handouts and materials.
- Remind the students that during the previous session they built their prototype.
- Today, students are going to test their ramps.

Marble Ramp Official Testing: 20 minutes

- Each team tests their prototype marble ramps while other teams observe.
    - Students will place their designs between the two cups. Their marble ramps should be free-standing, and should not be held by the students during testing. One at a time, 5 marbles will be rolled from the top cup to the bottom cup. Students should record how many of the 5 marbles were successfully transferred from the top cup to the bottom cup. Did the students lose anyone's luggage?
    - Celebrate each team's design by having the class applaud for that team after that team shares their design.
    - Students should complete The Airport Book: Test and Improve Your Device handout.

Reflection: 10-15 minutes

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- Slide 12: Ask students to discuss with their team:
    - What do you like best about your marble ramp?
    - What would change about your marble ramp?
    - What aspects of other team designs stood out to you?
    - Did other designs give you ideas for ways to improve your design?
    - What modifications will you make to redesign your marble ramp?
    - How did the materials affect the ability of the marble ramp to withstand the forces applied to them?
- 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 work with ramps.

Wrap Up: 10 minutes

- Ask students to place their handouts and materials in a safe location and clean up their area
- Explain that tomorrow students will be reconstructing their design based on what they learned from prototype testing today.
- Distribute Parent Letter

Activity 5

Introduction: 5 minutes

- Help students locate their handouts and materials
- Remind students that last time they tested their marble ramp.
- Today students will redesign their marble ramp and then test it.

Marble Ramp Redesign and Construction: 30 minutes

- Slide 12:
    - Students use what they have learned testing their designs to modify their ramps to make them better.
    - As the students are working on their new designs, walk around the room and ask them probing questions about their redesign. For example:
        - How well did your first design work?
        - Why are you making that change?

Redesigned Marble Ramp Testing: 20 minutes

- Each team tests their prototype marble ramps while other teams observe.
    - Students will place their designs between the two cups. Their marble ramps should be free-standing, and should not be held by the students during testing. One at a time, 5 marbles will be rolled from the top cup to the bottom cup. Students should record how many of the 5 marbles were successfully transferred from the top cup to the bottom cup. Did the students lose anyone's luggage?
    - Celebrate each team's design by having the class applaud for that

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team after that team shares their design.

Wrap Up: 20 minutes

- Ask students to place their handouts and materials in a safe location and clean up their area.
- Discuss text-to-self, text-to-text and text-to-world connections with the students again. Put the Text Connections handout on the overhead or Elmo machine so all students can see it and explain each type of connection.
- If time allows, read the story, *The Airport Book* 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 in their STEM notebooks.
- Slide 13: 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.

Activity 6 (optional)

Introduction: 5 minutes

- Remind students that last time they redesigned their marble ramps and tested them.
- Today students will research some details about planes and traveling on a plane.

Research Time!: 25 minutes

- Distribute The Airport Book: Research Time! student handout. Students use the Internet to research details about airplanes. You can assign all students the same airplane, assign an airplane to a group of students to research, or allow students to pick the airplane that they want to research.

Sharing Time!: 15-30 minutes

- Allow students to share what they learned. Allow students to share their mathematical process for how they calculated the number of passenger seats on the airplane. Having students who have an incorrect process for calculating the number of passenger seats share their work with the class is extremely beneficial for all learners as students need to understand that everyone makes mistakes—even teachers! And, making mistakes allows their brain to grow.

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Wrap Up: 5 minutes

- Ask students to turn to their partner and share one detail that they learned about their airplane.

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