**STEM Stories: The Most Magnificent Thing**

**Lesson Plan**

**STEM** **Career** **Connections:** Civil Engineering, Chemical Engineering, Architecture and Construction

**STEM Disciplines:** Science, Technology, Engineering, & Mathematics

**Non-STEM Disciplines:** English Language Arts

**Academic Content Standards**

**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.
* RL.3.9 Compare and contrast the themes, settings, and plots of stories written by the same author about the same or similar characters (e.g., in books from a series).
* W.3.3 Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences
* SL.3.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacherled) with diverse partners on grade 3 topics and texts, building on others’ ideas and expressing their own clearly.
* 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.

**Mathematics Standards:**

**Science Standards:**

**Design** **Challenge** **Problem/Scenario:**

**Engineering** **Design** **Challenge:**

**Essential** **Question Students Investigate:**

**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.

● The concepts of strength of materials and structural integrity are important for this problem. The design structure should hold weight without breaking or deflecting beyond safe limits.

**Prerequisite** **Knowledge** **(as connected to academic content standards)**

● Concepts Related to Energy in Grades PreK-2: A variety of sounds and motions are experienced. The sun is the principle source of energy.

● Concepts Related to Energy in Grade 3: Objects with energy have the ability to cause change. Heat, electrical energy, light, sound and magnetic energy are forms of energy.

● Concepts Related to Earth and Space Science in Grade 4: The surface of the Earth has been shaped and reshaped by a variety of processes.

**Materials** **List**

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| **Material** | **Quantity** **per** **Team** | **✓** | **Quantity** **per** **Kit** | **✓** |
| *Iggy Peck Architect by Andrea Beaty* | ~ |  | 3 |  |
| K’Nex Education Bridges Kits | 1 |  | 8 |  |
| Masses for Testing | ~ |  | 1 set |  |

**Day 1**

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| **Introduction: 15 minutes*** Sit in a chair and gather the students on the floor around you so they can all see the book.
* Remind the students of the full scope of the Engineering Challenge (Day 1, Day 2, Day 3, Day 4).
* Introduce *The Most Magnificent Thing* by Ashley Spires. Show them the cover of the book and ask them what they think the book might be about. Take a picture walk through the book to identify the main events at the beginning, middle, and end of the story.
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| **Pre-Reading: 10 minutes*** There are three main vocabulary words needed to understand this story: perseverance, imagination, and empathy.
* Show the following video clips to demonstrate the meaning of each word, and have a class discussion about each word after the video clips.
* Perseverance: <https://www.youtube.com/watch?v=iRQytOBTlN8>
* Imagination: <https://www.youtube.com/watch?v=0zQG41Rc6tI>
* Empathy: <https://www.youtube.com/watch?v=9_1Rt1R4xbM>
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| **Read Aloud: 20 minutes*** Read the book aloud to the students.
* As you read the book, stop to model connections you are making to other books and design challenges we have engaged in throughout the year. You should prepare these connections ahead of time. For example, the main character of this book is a designer, much like the main character of *If I Built a House*, and they both used their imagination to create something amazing.
* Invite students to share their own connections throughout and immediately after reading the story. This will tie this design challenge to the previous modules.
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| **Post Reading: 15 minutes*** Ask the students how the main character used perseverance and imagination to create her magnificent thing. Encourage the students to give specific examples from the story.
* Remind the students of the interviews they completed last time about their dream jobs. Explain that they are now going to pair up and interview a partner about a magnificent thing they need. They are doing *research* to help them make their own magnificent thing later in the design challenge. Engineers conduct research by talking to the people who will use their designs before they create them.
* Remind them about the word, empathy. By talking to someone else about what they need to make their life easier, we are being empathetic. Engineers need empathy to be able to design things to help people live better lives.
* Questions they should ask their partner include:
	+ What is your favorite thing to do when you are not in school?
	+ What jobs or chores do you have around the house?
	+ What types of things do you do to help your family?
	+ If you could have anything that would make any of these activities easier, what would it be?
	+ What would it have to do to be helpful to you?
	+ What would it look like?
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| **Quick Write: 15 minutes*** In their notebooks, ask the students to write about their Magnificent Thing. This can be an object for themselves or something to help the partner they interviewed. They should write what they would create, who would need it, and draw a picture of what it will look like.
* You can also provide sentence stems to provide support for struggling writers.
* Invite students to share their writing in an author’s chair. Students can ask questions of the author if time allows. Review the protocol for asking kind, constructive questions.
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| **Application: 20 minutes*** Display slide one of the PowerPoint
* Slide 2: Complete the journal entry for Day 1.
* Slide 3: Review the classroom rules with students. Set a goal together.
* Slide 4: Present the “Engineering Design Problem” and Challenge.”
	+ **Design Challenge Scenario:** Last week we built bridges following the directions from K'nex kits that would allow people to cross a river. This week you are Architect, just like Iggy Peck, and you have been commissioned to design a bridge that will cross a wider river.
	+ **Engineering Design Challenge:** Your team’s challenge is to design then create a prototype of a bridge that people and cars could use cross the wide river.
* Slide 5: Explain or share the “Design Goals”.
* Slide 6: Introduce the resources/materials available.
* Slide 7: Explain the design testing procedures.
* Slide 8: Explain the “Engineering Design Process”
	+ To differentiate instruction, the “Engineering Design Process” is on two handouts. More proficient readers should receive a copy of the “Engineering Design Process Graphic Organizer” and the handout labeled “Engineering Design Process (Full).”
* Slide 9: Have the students complete the “Ask” step of the Engineering Design Process.
	+ Ask the students to notice that the word Ask is in one of the circles of the “Engineering Design Process”.
	+ Share with students that we will be exploring more about bridges to answer the Ask questions displayed on the slide.
	+ Students should write the question they want to explore more about on their STEM Challenge handout.
	+ Walk around as the students complete the Ask step of the Engineering Design Process and query them about how they will research their question.
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| **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 by designing and building a bridge with K’Nex and testing to see how strong the bridge is.
* Remind students of the word empathy and how engineers use this in their everyday work.
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**Day 2**

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| **Set-Up** * Designate space for displaying and gathering available materials.
* Designate space for each team to collaborate and build their design ideas.
* Make sure all students will be able to see the presentation.
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| **Introduction: 15 minutes*** Remind the students that during the previous session they read and discussed the book *Iggy Peck, Architect* by Andrea Beatty and were presented with a Design Challenge Scenario and Engineering Design Challenge. Generate a discussion about the Design Challenge Scenario and Engineering Design Challenge. Do a “picture walk” through the book to remind students of the main idea.
* Slide 10: Have students complete the journal prompt and encourage them to share their answers with the class.
* An example of something that has been changed by engineers to make it better would be the inside of cars. Cars did not have seat belts. When people started to be injured in car accidents, an engineer designed a way to make the car safer. The first patented seat belt was created by American Edward J. Claghorn on February 10, 1885 in order to [keep tourists safe](http://www.secondchancegarage.com/public/seat-belt-history.cfm) in taxis in New York City. Over time, car manufacturers began installing them in all cars.
* Another example is the electric self car-starter invented by Charles Kettering in 1915. Before this invention, people had to use a hand crank to start the car-no key required. It was a lot of dirty work.
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| **Engineering Design Process: Improve: 15 minutes*** Distribute the Redesign Idea Sheet handout and a STEM Challenge handout.
* Display slide 11 of the PowerPoint:
	+ Ask the students to notice that the word Improve is in one of the circles of the “Engineering Design Process”.
	+ Students should improve their bridge by making it longer so it can cross bigger rivers.
	+ Students should use the Redesign Idea Sheet to help them critique the bridge they made last week and think through what will work or not work for their new bridge design.
	+ Students should then draw a picture of their redesigns on their STEM Challenge handout in the Improve box.
	+ Walk around as the students complete the Improve 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 build a structure 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.
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| **Engineering Design Process: Plan: 15 minutes** * Display slide 11 of the PowerPoint:
	+ Students should Plan as a team what their structure will look like.
	+ Students can use teammates’ ideas or a combination of the teams’ ideas, but remind them that they must create one structure together as a team!
	+ Students should draw a picture of their bridge on the back of their Redesign Idea Sheet. Allow the students to see the K’Nex boxes with the different size piece options. This bridge should be 9 green plates long.
	+ 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.
	+ Before allowing teams to build their redesigned bridge, require them to gain approval of their sketch of the team’s prototype design idea.
	+ Make sure students have a list of any additional knex piece they need.
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| **Engineering Design Process, Create: 30 minutes*** Slide 11: Teams build their redesigned bridge using the knex from their first bridge and additional pieces from the K'nex kit as needed.
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| **Wrap Up: 5 minutes*** Ask students to place their handouts and materials in a safe location and to clean up their area.
* Distribute a parent letter to each student.
* Share with the student that next time we will begin to test their redesign.
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**Day 3**

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| **Introduction: 10 minutes*** Show the students the book, *Iggy Peck, Architect* by Andrea Beatty, 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 redesigning their bridge to help more people cross a bigger river.
* Help teams of students locate their handouts and materials.
* Remind the students that during the previous session they built their own longer bridge
* Today, students are going to finish building and test their new designs.
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| **Structure Redesign Construction: 20 minutes*** Slide 11:
	+ As the students are working on completing 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?
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| **Bridge Structure Testing: 30 minutes*** Slide 12:
* Before testing, set up the testing area by placing two tables 20 inches apart.
* Students will place their new design on the tables so that the bridge spans the gap. Then they will add weight to the bridge one at a time and calculate how much weight their new bridge will hold.

**Compare** Students will compare the amount of weight their new bridge held to the amount of weight their original design held and determine which bridge held the most weight. |
| **Reflection: 10 minutes*** Slide 12: Ask students to discuss with their team:
	+ Which design held the most weight?
	+ What aspects of other team designs stood out to you?
	+ Did other designs give you any ideas for ways to improve your design?
	+ What modifications will you make to redesign your structure?
	+ How did the materials affect the ability of your structure to divert the flow of lava and protect the buildings?
* 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 and build lava flow protection structures.
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| **Wrap Up: 15 minutes** * Ask students to place their handouts and materials in a safe location and clean up their area.
* 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.
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