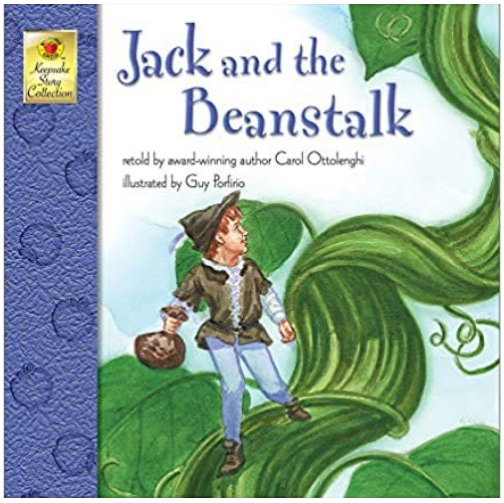
TEXAS MOBILE STEM LABS

LESSON: Jack and the Beanstalk (Grades K-2)

+ OVERVIEW



In this design challenge, students will receive a problem inspired by the story *Jack and the Beanstalk* by Carol Ottolenghi. In the story, Jack climbs a magical beanstalk, where he finds a castle from which he steals several items before returning home. The students will be presented with the following problem: “Jack wants to go back to the castle in the sky to return the hen and the harp he stole, but he is out of magic beans. He does not know how he will get back to the castle. Today, you are going to put on your engineering hat to help Jack build a “beanstalk” that can reach all the way to the giant’s castle in the sky so he can return the stolen items.” Students will engage in a STEM challenge to build the tallest tower in 25 minutes that can hold a toy figure (Jack) for one minute. Teams will receive bonus points if their structure can withstand a 30-second windstorm before Jack safely returns to his home on the ground.

+ 2021 Science TEKS covered in this design challenge

Kinder TEKS: K.1.B, K.1.E, K.1.G, K.6, K.13.A

Grade 1 TEKS: 1.1.B, 1.1.E, 1.1.G, 1.6.A

Grade 2 TEKS: 2.1.B, 2.1.E, 2.1.G, 2.6.A, 2.6.C, 2.13.A

+ Math TEKS covered in this design challenge

Kinder TEKS: K.2.A, K.2.C, K.5, K.6.E, K.7.A

Grade 1 TEKS: 1.3.D, 1.3.E, 1.5.A, 1.7.A

Grade 2 TEKS: 2.2.B, 2.4.A, 2.9.D

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+ ELAR TEKS covered in this design challenge

Kinder TEKS: K.7.C, K.8.A

Grade 1 TEKS: 1.1.D, 1.8.C, 1.9.A

Grade 2 TEKS: 2.1.D, 2.6.C, 2.8.C, 2.9.A

+ Technology Applications TEKS covered in this design challenge

Kinder TEKS: K.3.A, K.3.B

Grade 1 TEKS: 1.3.A, 1.3.B, 1.5.A

Grade 2 TEKS: 2.3.A, 2.3.B

+ The students will be able to:

- Read *Jack and the Beanstalk*
- Build a strong structure by applying an understanding of the physical properties of objects, and smaller units can be combined to make new objects
- Classify building materials by their physical properties
- Identify structures of a plant
- Count forward and backward to at least 20 with and without objects
- Use measuring tools to measure the length of objects
- Give an example of a measurable attribute of a given object, including length, capacity, and weight
- Solve a problem using the engineering design process
- Describe the elements of plot development, including the main events, the problem, and the resolution for texts read aloud with adult assistance or independently
- Demonstrate knowledge of distinguishing characteristics of well-known children's literature such as folktales, fables, fairy tales, and nursery rhymes
- Work collaboratively with others by following agreed-upon rules for discussion, including listening to others, speaking when recognized, making appropriate contributions, and building on the ideas of others
- Make and correct or confirm predictions using text features, characteristics of genre, and structures
- Explore and collect many types of data, such as preferences or daily routines of people, events, or objects

- Identify and collect non-numerical data, such as weather patterns, preferred reading genres, and holidays

+ Students will use the following STEM fluency skills:

- Communication
- Collaboration
- Creativity
- Critical Thinking
- Resilience
- Time/Resource Management
- Innovation
- Adaptability

+ Materials needed for this design challenge and their cost:

Construction Paper	1 counter per sheet
Toilet Paper Rolls	1 counter per roll
Tape	5 counters per roll
Glue Stick	4 counters per stick
Newspaper	1 counter per sheet
Scissors	1 counter per pair
Chenille Stick	1 counter per stick
Toy Jack	No Cost

Teacher's Note: For Kindergarten, we recommend also providing small building blocks at one counter a piece if available. Students will have some trouble using adhesives and scissors. As a result, extra care and monitoring will be needed to assist students. Higher achieving students can be offered fewer sticks and straws per counter.

+ Facilitator materials needed:

- *Jack and the Bean Stalk* by Carol Ottolenghi
- Projector and computer
- Slide deck for the lesson
- Copies of the scorecard for each group
- Fan with multiple speeds
- Timing device

+ FACILITATION GUIDE

SECTION	PROCEDURE
INTRODUCTION	**Slide 1: Jack and the Beanstalk** **Slide 2: Read Aloud** > Read *Jack and the Beanstalk.* ▪ Summarize what happened on each page. ▪ Ask students if they think it is possible for a beanstalk to grow so large it can reach the clouds. Ask students if it is possible to build a structure so high it can reach the clouds. ▪ Explain to students that there are jobs that specialize in building towers, although maybe not as high as the beanstalk Jack climbed. The people who do these jobs are called engineers. They help design and build the things people see and use every day. **Slide 3: Engineering Design 1** > Ask students the question: what is engineering? ▪ Explain to students that engineering is when engineers take what they know and apply it to solve problems by designing a product or process. ▪ For example, phones could once only be used at home or in specific locations. Why is this a problem? (Needing to make a call outside the home). What solution did engineers design to fix that problem? (Cell phones). • *Teacher's Note: Any example can be used here, but focus on examples that students are familiar with.* **Slide 4: Engineering Design 2** > Ask students the question: What are some examples of engineering jobs? ▪ *Teacher's Note: If students have trouble giving examples, ask students who makes the things they use. Who makes refrigerators, cars, helmets, cell phones, and sneakers?* **Slides 5-8: Engineering Jobs 1-4** > Show students pictures related to engineering jobs connected to the story. > Architecture ▪ Ask students what they see in the pictures. ▪ Explain to students the process of building these buildings is called architecture, which is the combination of art and science to design and build buildings. ▪ Ask students who they think built the castle. Explain to students that an architect would have been in charge of designing and

building it for the giant. Maybe the giant was an architect himself!

- Bioengineering
  - Ask students what they see in the pictures.
  - Explain to students that engineers who study crops and plants are called bioengineers. They use science to help the Earth! Some of the work they do can help make crops or plants grow bigger.
  - Ask students if they remember any plant growing very big from the story. Explain to students that perhaps the man who gave Jack the magic beans was a bioengineer!
- Civil Engineering
  - Ask students what they see in the pictures. Ask them: How does it look different from architecture?
  - Explain to students what they are seeing in the pictures is called civil engineering. While architecture combines art and science to build buildings, civil engineers use math and a type of science called physics to build buildings that help people. Architects and civil engineers are also different because while architects mainly focus on buildings, civil engineers will build many structures like bridges, highways, towers, and water systems!
  - Ask students if they think climbing a beanstalk is safe. What could make it safer? Explain to students that a civil engineer would be the one to help make that beanstalk safer.
- Wind Engineer
  - Ask students what they see in the pictures.
  - Explain to students that what they are seeing are wind turbines or windmills. Ask students what they think a windmill does. Explain that these structures help convert the wind into energy!
  - Ask students how learning about the wind is important? Explain to students there are many positive and negative aspects of wind. It can help people cool down on a hot day, but what about if it's too strong? If the wind is too strong, it could blow things down and be very dangerous!
  - Ask students if Jack could climb the beanstalk on a windy day. Explain to students that it could be very dangerous because the beanstalk might move, or Jack might lose his balance.

Slide 9: Engineering Design 3

- Ask students the question: who can be an engineer?
  - Anyone!

Slide 10: Engineering Design Process

- Ask students if they think all engineers solve their problems in one try. Explain to students that it takes many tries to get something correct in

engineering. In engineering, there is no such thing as a mistake, only opportunities to learn. It is okay to fail. Just find the mistake and correct it. In engineering, there is never one correct solution. There are always many solutions to a problem and always improvements that can be made. The steps that engineers take to find these solutions are called the *engineering design process*.

> The teacher reads the first step to the students. (Identify)
    - What does identify mean? (To point out or find). Engineers design solutions. What do they need to know first before they can find the answer? (The problem)
    - How do people know when they have found the correct answer? In engineering, there are no correct answers, just better ones. Explain to students that there are expectations that engineers must meet called *criteria*. For example, when engineering a football, what does a football need to do? (Bounce, look a certain way, have laces, have air inside, etc.). Those things are all called criteria. By comparing the design to the criteria, an engineer can determine if their solution will work. Is a child-sized football the same as an adult football? The criteria for both footballs include leather, the white laces for fingers, and the shape. However, the two footballs would have different criteria for the size. The footballs are similar but different because of different criteria.
    - Once the criteria are understood for the design challenge, what are some potential challenges that could make it difficult for an engineer to design their solution? (Money, time, materials, etc.) Explain to students that these rules are called *constraints* or rules that engineers must follow. Engineers are given constraints they must follow when finding the solution to a problem. Think about football again. What are college and professional footballs made from? (Leather). What if instead, the rule (or constraint) was to not use leather, could another type of football be made instead? Many of the footballs for sale are made of rubber because the engineer had different constraints.
> The teacher reads the next step. (Imagine)
    - Ask students what imagine, or imagination, means. Are these things real or tangible? They may not be real, but they help give us ideas about what things could be. In this step, see what materials are available, then brainstorm, or think about possible ideas/solutions to the problems.
    - Explain to students that there are no right answers in engineering. Start with as many ideas as possible.
> The teacher reads the next step. (Plan)
    - The third big step of the engineering design process is to plan out the idea. Make sure that what is designed can be repeated.

	A plan will help an engineer identify where mistakes happen so they can be fixed. ▪ When planning, begin with the brainstorming phase. Each team member will contribute their ideas, and then the team combines the different ideas! ▪ Once ideas are combined into a single group idea, determine what materials will be used for the solution and make sure the design has met the criteria and constraints of the project. > The teacher reads the next step. (Create) ▪ The fourth step is to create! Since this is the very first creation, it is called a *prototype*. A prototype is a first or preliminary model of something from which other forms are developed or copied. A prototype is created to test the engineer's idea or concept. Engineers ask themselves, "Did the idea work the way we wanted it to?" After testing the idea, the engineer will make improvements to the prototype. > The teacher reads the last step. (Improve) ▪ Finally, the last step is to improve. How does an engineer know if the prototype did well on the test? It must meet certain expectations and follow some rules. But how do engineers determine how well it met the expectations and how well it followed the rules? In school, how do you know if you mastered something? (Grades). The prototypes made today will be scored using a scorecard or rubric. By looking at the score, each team will determine if the design could be better. If improvements should be made, then the team will revisit the plan and decide what to do to improve the score. Remember, there are no correct answers in engineering, just better solutions.
IDENTIFY	**Slide 11-12: Identify -** Problem > The teacher will read the bolded scenario to students. ▪ Ask students what problem Jack is having right now. > Explain to students that they will put on their engineering hat today to help Jack build a "beanstalk" that can reach the giant's castle in the sky. **Slide 13: Identify -** Criteria (Desired Outcomes) > Explain to students that criteria are what engineers use to determine if they have successfully solved the engineering problem. > A successful tower design should include the following: ▪ A height of 40 centimeters • *Teacher's Note: Students in K-2 should not be expected to measure their tower using standard measurement. The teacher will need to measure and mark a 40-centimeter-high mark and a 30-centimeter-high mark at the station where students are working. If*

there is no place to mark a height, a teacher could use two different colored strings that are 30 centimeters and 40 centimeters long or use a 30-centimeter and 40-centimeter dowel to measure next to their tower. Differentiate for higher achieving students by setting the criteria to 60 centimeters.

- A "leaf/stem seat" for Jack to sit on
- Hold Jack for one minute during the test
  - *Teacher Note: The teacher will be in charge of timing the one minute.*

Bonus points will be awarded if the tower holding Jack can withstand a windstorm for 30 seconds.

- A fan will be used to represent the windstorm.
- Demonstrate the fan set to low or "1" for students and let them feel the moving air.

Slide 14-15: Identify - Constraints (Rules)

> Explain that constraints are the rules that engineers must follow.

> Explain the following constraints for this engineering design activity:

- Time Limit: Students will have 25 minutes to build the tower.
  - *Teacher's Note: The teacher will time the design challenge and give the students time checks periodically to assist the teams with their time management.*
- Materials: Students will be able to use no more than 20 items to build the tower.
- Counters: Students will have 20 counters to complete this challenge.
  - *Teacher's Note: 20 counters will be given to each group. Pre-bag the counters for easy distribution to each group. When students go to the supply table, they will hand the teacher one counter for each item they "buy". They can buy up to 20 items to build their prototype.*
- Collaboration: One design element from each team member must be used in the final design. Explain to students that a design element is taking one part of someone's idea and adding it to another.
- Redesign: Each team can test their prototype as many times as needed during the 25-minute design phase. Remind students what a prototype is. It is the first creation of our design.
  - *Teacher's Note: When a team is ready to test their design, they should raise their hand and the teacher should assist the team with their score. If the team receives a low score on any part of the design, the team should redesign if they still have time.*

IMAGINE	**Slide 16: Imagine -** Explore Materials > Introduce materials to students by showing each item as it is read out loud on the materials list. Explain to students that when engineers describe items, they talk about properties like color, size, and flexibility. Ask students to identify the properties of each material. After each material, ask students if it is similar to any of the other materials they have seen and what the similarities and differences are. ▪ Ask students to reclassify the objects based on what they are made of or how they can be used. > After students have practiced classifying the materials, they will be allowed to combine the materials however they wish to build a tower that meets the criteria for Jack. **Slide 17: Imagine –** Brainstorm Ideas > Give students one minute to individually design and draw a plan of what they think the tower should look like. Emphasize that students should not talk during this minute or share ideas with each other. Remind students their ideas will be used as design elements for the final design. > After a minute, give students five minutes to present and share their ideas with their group. Let students know that they should focus on key aspects of their idea that they like and want to be used as design elements for the final design when sharing. ▪ *Teacher's Note: If students are struggling with an idea for their design, provide ideas without giving the solution. For example, "This is a design that I tried earlier, but it failed. What could I do to improve it?" Emphasize that the design failed to reinforce that it is okay to fail and to let students know they cannot copy the design and expect success.*
PLAN	**Slide 18: Plan –** Gather Materials > Hand out the scorecard that will be used during the design challenge. Review the testing criteria with the class and answer questions. The testing criteria will inform their design decisions. > Have students collaborate to come up with a final design. Let students know they must include at least one element from each team member for their final design. > Review the design criteria: A successful tower design should include the following: ▪ A height of 40 centimeters ▪ A "leaf/stem seat" for Jack to sit on ▪ Hold Jack for one minute during the test Bonus points will be awarded if the tower holding Jack can withstand a windstorm for 30 seconds. ▪ *Teacher's Note: Students will not be expected to rank themselves or calculate their scores, but the teacher should*

	explain how they will earn points. The testing criteria will inform their design decisions. > They will need to select the materials to be used for the design. Students will have 20 counters to "purchase" materials for their build at the classroom supply table. The prices used in this challenge can be found in the materials list. Students will raise their hands when they are ready to purchase materials and will be guided by the teacher. Students can go over the counter limit if they want but remind them that they will lose points on their scorecard. **Slide 19: Plan –** Team Member Responsibilities > Each team member must be given a responsibility, such as materials manager, banker, head engineer, and quality control manager.
CREATE	**Slide 20: Create -** Design Your Tower > Let students know to have fun, be creative with their designs, and work together. > Remind students that being an engineer is not about getting the solution on the first try. There is no right answer, just better solutions. **Slide 21: Identify** – Criteria > Display the reminder slide for students to look at while working. **Slide 22-23: Create –** Test > The teacher will bring the fan to each team when they are ready to test. They will go through each of the categories on the scorecard with the students as testing is done by the teacher. > The teacher will then recap the point total with the students and how many points the team received for each category.
IMPROVE	**Slide 24: Improve –** Redesign/Discussion > Students will reflect on their scores and discuss: ▪ What worked? • *Teacher's Note: Focus on the materials being used and ask what properties of those materials might have helped. Check and see if any students combined materials to make their tower stronger. Check and see if any students cut or folded the materials to make their tower stronger.* ▪ What did not work? • *Teacher's Note: Focus on the materials being used and ask what properties of those materials made it not work well. Check and see if any students cut or folded their materials, and if that made the tower weaker.* ▪ What do you want to improve?

- *Teacher's Note: Focus on engineering aspects with students. Ask students if they found a solution or just part of one. Reinforce that it is okay not to succeed on the first try and that engineering is about making improvements over time. Ask students if they would design their tower differently if they had no rules, how? Ask students if working together was difficult. Learning to work together is very important and it is easier to find a solution with many ideas rather than just one idea.*