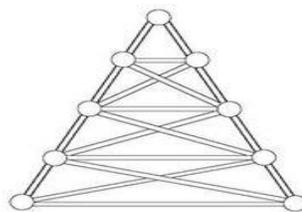


# MeTEOR Learning Modules

## STEM MEA (Model Eliciting Activity)

### Designing a Tower





## Marshmallow Spaghetti Tower

### Reflective Planning

#### Description/Summary of Lesson:

The Marshmallow Challenge is a fun and instructive design exercise that encourages teams to experience simple but profound lessons in collaboration, innovation and creativity. It is designed to reinforce the engineering model of design, build and modify.

The task is simple: In eighteen minutes, teams must build the tallest free-standing structure out of 20 sticks of spaghetti, one yard of tape, one yard of string and one marshmallow. The marshmallow needs to be secure on top of the student's structure.

#### Essential Questions:

- What are the specific qualities that go into engineering to design a free standing tower?
- How is math used in the planning stages of designing a spaghetti tower?

**Suggested Grade Level:** Grades 1-2

**Approximate Time:** One day (30 minute class periods)

**Teacher's Role:** Facilitator

**Class set-up:** Groups of three-four students at tables or desks put together

#### Success Standards:

- Students can plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
- Students can define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time or cost.
- Students can generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and the constraints of the problem.

**Learning Purpose:**

- Students will plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object.
- Students will understand that some shapes are stronger than others.
- Students will understand that even weak materials can be made stronger with good design techniques.

**Vocabulary:**

- Height
- Weight
- Support
- Tension
- Load

**Math Practices:**

- MP 1: Make sense of problems and persevere in solving them.
- MP 3: Construct viable arguments and critique the reasoning of others.
- MP 4: Model with mathematics.
- MP 6: Attend to precision.

**Depth of Knowledge:**

- DOK Level 3: Strategic Thinking

**Materials: (per group)**

- 20 Sticks of Spaghetti
- 1 Yard of Tape (scotch or masking)
- 1 Yard of String
- 1 Marshmallow

**Summary of Tasks/Experiences****Spark Activity:**

- Begin by asking students if they enjoy marshmallows. Talk about weight and properties.
- Have a similar follow up with a discussion of spaghetti.
- Share with students that they are going to make a free-standing tower using these raw materials.
- They will compete against others for building the highest tower.

## Lesson Descriptions:

### Introduction:

The teacher will:

- explain the challenge.

The students will:

- build the tallest freestanding structure in just 18 minutes using no more than 20 sticks of spaghetti, one yard of tape, one yard of string and one marshmallow.
  - The marshmallow must be on top and cannot be deformed to hold it in place.
  - The structure has to stand firmly on its own; it cannot be propped up, held or suspended from the ceiling.

### Teacher facilitates class:

The teacher will:

- start the countdown clock and the music with the start of the challenge.
- walk around the room to see the development of the structures as well as notice the patterns of innovation most teams follow.
- remind teams of the time: count down the time. (Typically, the leader calls the time at 12 minutes, 9 minutes (halfway through), 7 minutes, 5 minutes, 3 minutes, 2 minutes, 1 minute, 30 seconds and a 10-second countdown.)
- share how teams are doing with this challenge. Let the entire group know how teams are progressing. Call out each time a team builds a standing structure. Build a friendly rivalry. Encourage people to look around. Don't be afraid to raise the energy and the stakes.
- remind teams that holding their structures will disqualify them. Several teams will have a powerful desire to hold onto their structure at the end — usually because the marshmallow, just installed at the apex, is causing it to buckle. The winning structure must be stable after the time runs out. Ask everyone to sit down so they can see the structures. Just over half the teams are likely to have standing structures.

### After the Challenge:

The teacher will:

- measure the structures. Measure from the shortest standing structure to the tallest and call out the heights. Have someone record the heights.
- identify the winning team. Ensure they get a standing ovation and a prize (if you've offered one).

- wrap up with the lessons of the Marshmallow Challenge. Describe some of the key lessons of the challenge. Discuss:
  - What building techniques make the tower stronger?
  - Does the placing of the marshmallow affect the strength of the tower?
  - Could you build a stronger tower with more of the same materials? What alternative materials would be better?
  - Does the size of the base alter the strength of the tower?
  - How do you think you worked as a group? Did you assume different roles? Did all groups work in the same way?

## Student Engagement

**Social/Emotional Engagement:** Students will use social, interaction skills for completing projects with peers.

**Physical Engagement:** Students will design and build the spaghetti tower while working in small groups.

**Cognitive Engagement:** Students will work together using concepts such as structure, base, height and support in an engineering design project.

## Evidence of Learning

### Checks for Understanding/Expected Outcomes:

- Students will design their spaghetti towers.
- Students will articulate how support and balance were used in this activity.
- Students will answer questions on Standing Strong Worksheet.
- Students will compare their model to others to understand why some models are stronger than others.
- Students will be evaluated using the included Rubric.

### Teacher Notes:

- Stick to the time frame. Students will expect their tower to hold the marshmallow, but many will not.
- The Standing Strong Worksheet should be completed before the rebuild is done. It evaluates the understanding of the engineering model of design, build and modify.
- Allowing a rebuild will increase understanding of the STEM engineering, design, build and modify process.

Team Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Standing Strong Worksheet

1. Draw a large diagram of your Spaghetti Tower in the space below.
2. What do you like and dislike about your current design?
3. What was your biggest obstacle? How did you overcome it?
4. If you had an opportunity to redesign your tower, what would you change?
5. How did you personally feel while doing this activity? Did you ever want to give up?
6. If you could add another material to the mix, what would it be and why?
7. What was your contribution to the group?

Team Name: \_\_\_\_\_ Date: \_\_\_\_\_

## Standing Strong Worksheet Expected Responses

1. Draw a large diagram of your Spaghetti Tower in the space below.  
Pictures will vary.

2. What do you like and dislike about your current design?

Possible answers: fell over too quickly, no strength, top heavy

3. What was your biggest obstacle? How did you overcome it?

Possible answers: using enough spaghetti to not make it top heavy, teamwork

4. If you had an opportunity to redesign your tower, what would you change?

Answers will vary: communication, stronger base,

5. How did you personally feel while doing this activity? Did you ever want to give up?

Frustrated, that it wasn't possible.

6. If you could add another material to the mix, what would it be and why?

Answers will vary: More marshmallows, for glue

7. What was your contribution to the group?

Answers will vary

### Marshmallow/Spaghetti Structure Rubric

Category	4	3	2	1
<b>Problem Solving</b>	Actively looks for and suggests solutions to problems.	Refines solutions suggested by others.	Does not suggest or refine solutions but is willing to try other's solutions.	Does not try to solve problems or help others solve problems. Lets others do the work.
<b>Contributions</b>	Routinely provides useful ideas. Leader.	Occasionally provides useful ideas. Strong team leader.	Rarely provides useful ideas. A satisfactory team member.	Provides no useful ideas or refuses to participate.
<b>Attitude</b>	Never is publicly critical of the project or others. Positive attitude.	Rarely is publicly critical of the project or others. Often has a positive attitude.	Occasionally is publicly critical of the project or others. Sometimes has a positive attitude.	Often is publicly critical of the project or others. Has a negative attitude.
<b>Focus on the Task</b>	Constantly stays focused on task.	Mostly stays focused on task.	Hardly stays focused on task.	Rarely stays focused on task.
<b>Working with others</b>	Almost always listens and shares with others.	Mostly listens and shares with others.	Occasionally listens and shares with others.	Rarely or never listens and shares with others.
<b>Comprehension of Concepts</b>	Demonstrates understanding of concepts.	Demonstrates understanding of most concepts.	Demonstrates understanding of a few concepts.	No demonstration of understanding of concepts.

**Total \_\_\_\_\_/24 Points**



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