# Marshmallow Challenge

2nd Grade

Unit 6 – Taking Care of Ourselves

Text Connection: *The Skeleton Inside You* by Phillip Balestrino

| **Design Challenge Summary** |
|---|
| **Challenge:** What will the students be required to do? |
| The main job of the skeleton is to provide support for our body. Today your challenge is to build the tallest free-standing spaghetti structure that can support a large marshmallow on top in 18 minutes. Your structure has to stand on its own for 5 seconds in order for the height to count. |
| **Standards:** What standards are addressed? |
| **Science:**<br>NS.1.2.1 Communicate observations orally, in writing and in graphic organizers<br>NS.1.2.2 Develop questions that guide scientific inquiry<br>NS.1.2.3 Conduct scientific investigations as individually and in teams<br>NS.1.2.4 Estimate and measure length…<br>NS.1.2.5 Collect measurable empirical evidence in teams and as individuals<br>NS.1.2.6 Make predictions in teams and as individuals based upon empirical evidence<br>NS.1.2.7 Use age-appropriate equipment and tools in scientific investigations<br>LS.2.2.5 Identify the major parts and functions of the skeletal system<br>PS.5.2.2 Investigate the effect of physical phenomena on various materials<br>PS.6.2.1 Investigate the relationship between force and motion<br><br>**Math:**<br>Mathematical Practice Standards<br>2.MD.1 Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes<br>2.MD.3 Estimate lengths using units of inches, feet, centimeters, and meters<br>2.MD.7 Tell and write time from analog and digital clocks to the nearest five minutes<br>2.MD.9 Generate measurement data by measuring lengths of several objects to the nearest whole unit, or by making repeated measurements of the same object. Show the measurements by making a line plot, where the horizontal scale is marked off in whole-number units<br><br>**Other:**<br>W.2.2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points and provide a concluding statement or section<br>W.2.3 Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts and feelings, use temporal words to signal event order, and provide a sense of closure<br>W.2.7 Participate in shared research and writing projects<br>SL.2.1 Participate in collaborative conversations with diverse partners about grade 2 topics and texts with peers and adults in small and larger groups<br>SL.2.3 Ask and answer questions about what a speaker says in order to clarify comprehension, gather additional information or deepen understanding of a topic or issue<br>SL.2.4 Tell a story or recount an experience with appropriate facts and relevant, descriptive details, speaking audibly in coherent sentences<br>SL.2.6 Produce complete sentences when appropriate to task and situation in order to provide requested detail or clarification |

# Marshmallow Challenge

**Result:** What will students know, value, and be able to do as a result of the lesson? What's the big idea?

Know and apply the engineering design loop process.
Demonstrate ability to modify designs based on observations and predictions.
Work collaboratively on solving a problem.
Experiment with the effect of weight/force on a structure.
Use measurements effectively.
Generate line plots using measurement data.

**Assessment:** What evidence will be used to determine student learning?

Did they build a "free-standing" structure that would support a large marshmallow on top?
How tall was their tower? How did it compare to the other towers? (measurement data)
Did they follow the design loop process?
Did they work collaboratively?

**Prior Knowledge/Experiences:** What prior content knowledge and skills will the students need?

Experience with the Engineering Design Loop process
Connections to the Mathematical Practices
Investigations/inquiry in Science
Experiences with measurement in standard units

**Summary/Connections:** How will this design challenge connect with new/future learning, other content areas, real world experiences, etc.?

This lesson will help students develop problem solving skills and collaboration skills that are essential in succeeding in the 21st century. It will allow student the opportunity to transfer and apply skills from various content areas within one task.

***This challenge was adapted from the "the Marshmallow Challenge" from eGFI, attached at the end of this document.**

**Math – Measurement Data:**
After students have completed their tasks, generate a line plot with the measurement data of the heights of the towers. Discuss the data and discuss why certain towers were "taller" and still supported the marshmallow. **2.MD.9**

**As a summary activity, you could engage students in:**
**W.2.2** Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points and provide a concluding statement or section
**W.2.3** Write narratives in which they recount a well-elaborated event or short sequence of events, include details to describe actions, thoughts and feelings, use temporal words to signal event order, and provide a sense of closure

**Extensions:**
How could you design your tower to be taller and still support the marshmallow?
Even though a marshmallow is "light", why was it hard to support it on top?
Research tall towers in the US or the World. Find out what engineers do structurally to stabilize the towers and how they are able to build them as tall as they are, etc. **W.2.7**

# Marshmallow Challenge

| **Materials/Equipment/Preparation:** What materials and equipment will students need to successfully complete this design challenge? |
|---|
| 20 pieces of spaghetti<br>1 meter of tape<br>1 meter of string<br>1 large marshmallow<br><br>Additional supplies:<br>Scissors<br>Timer/Stopwatch |

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The goal of our design challenge is "learning", so we are not looking at this like the lesson plan did – with winning teams and in disqualifying teams.

We want our students to use the design loop process to refine their structures and learn from their mistakes in the process.

Please use the attachment as an "additional resource" for this task.

You can also view a great video of this challenge on TED Talks that will provide information about the challenge and what it reveals about collaboration. This will be a great informational video for you, as the teacher, to view prior to giving the challenge. It shares lessons that were learned from doing this task with a variety of learners, from Kindergartners to Business students in college. (This is not necessarily a video to share with your students)

http://marshmallowchallenge.com/TED_Talk.html

# Marshmallow Challenge


The main job of the skeleton is to provide support for our body. Today your challenge is to build the tallest free-standing spaghetti structure that can support a large marshmallow on top. You have 18 minutes to complete the challenge. Your structure has to stand on its own for at least 5 seconds for the height to count.

Group Supplies:

20 pieces of spaghetti, 1 meter of tape, 1 meter of string, 1 large marshmallow

Other supplies: scissors, timer/stopwatch

# Marshmallow Design Challenge

Posted on September 28th, 2011 by Mary Lord

*(Adapted from The Marshmallow Challenge by Tom Wujec, a Fellow at Autodesk, a world leader in 2D and 3D technology serving the design, engineering, and entertainment industries.)*

**Introduction:** This fun design/build exercise teaches some simple but profound lessons in collaboration, innovation, hidden assumptions, and creativity that are central to the engineering process. Surprising lessons emerge when each teams' performance is compared. What were the hidden or false assumptions? Who tends to do poorly or best? Why? What improves performance? What hinders it? Autodesk's Tom Wujec, who developed much of this activity, calls the marshmallow challenge one of the "fastest and most powerful techniques for improving a team's capacity to generate fresh ideas, build rapport, and incorporate prototyping – all of which lie at the heart of effective innovation."

**Summary**

In this lesson, student teams have a limited period of time (18 minutes) to build the tallest free-standing spaghetti structure that can support a marshmallow. They learn how engineers collaborate to design, test, and improve on their ideas, as well as examine hidden assumptions that can derail the creative process and final product.

**Grade level**: K – 12

**Time:** 45- 60 minutes

**Learning Objectives**:

After this activity, students should be able to:

Understand the importance of teamwork and failure in science and engineering
Understand that some shapes are stronger than others
Understand that even weak materials can be made stronger with good design techniques, and that distribution of mass is an important consideration when building a tower
Understand that compression and tension affect the stability of a structure
Compare their model to others to understand why some models are stronger than others
Understand why engineers consider tension and compression forces when designing a building or structure

**Standards**

**International Technology Education Association** [Grades 6 - 8]

J. Make two-dimensional and three-dimensional representations of the designed solution.
G. Structures rest on a foundation.

**National Science Education Standards** [Grades 5 - 8]

Communicate the process of technological design. Students should review and describe any completed piece of work and identify the stages of problem identification, solution design, implementation, and evaluation.
Evaluate completed technological designs or products.
Technological designs have constraints.

**Materials**

For each team:

20 pieces uncooked spaghetti (regular, not angel hair or thin spaghetti)
3 ft. of string that can be easily broken by hand (Or, have a pair of scissors handy on your desk but don't tell students they can use them—let them figure it out!)
1 fresh marshmallow (standard fluffy variety, not mini or jumbo size, and not stale or hard)

3 ft. of masking tape
Paper bags – standard lunch size – or manila envelops to contain above materials

For the contest:

Measuring tape

**The Challenge**

Build the tallest free-standing 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.

**Preparation**

In advance of the exercise, create a "marshmallow challenge kit" for each team. Kits should contain 20 sticks of spaghetti, 1 yard of masking tape, 1 yard of string, and 1 standard half-inch marshmallow. These ingredients should be placed into a paper lunch bag, which simplifies distribution and hides the contents, maximizing the element of surprise.

Also ensure that you have the following tools to run the challenge:

**Measuring Tape**: Have a contractor's retractable measuring available after the challenge is finished so you can measure the height of the structures.
**Countdown Application or Stopwatch**: The actual marshmallow challenge takes 18 minutes. Eighteen minutes seems to be the magic time. Twenty minutes is too long and 15 is too short. You can use a stopwatch, but better yet is to use a video projector and display the countdown time. For Shareware Windows applications, consider http://www.timeleft.info/ and http://www.orzeszek.org/blog/2009/08/21/simple-countdown-timer-for-windows/. For a Mac, consider, http://www.baldgeeks.com/3-2-1.htm
**Video Projector and Sound System** (optional): For more impact, use a video projector to deliver the Marshmallow Challenge Presentation (or your own) and a sound system for music during the challenge.Time out a play list of exactly 18 minutes of music. You'll want the challenge to end at the conclusion of the last song.

**Activity**

**1. Divide students into teams of four and distribute the Marshmallow Challenge Kits.**

**2. Go through the rules.** You will want to repeat the rules several times during the activity; reinforce them visually by projecting them on a screen or providing written copies.

**The RULES**

✦**Build the Tallest Freestanding Structure**: The winning team is the one that has the tallest structure measured from the tabletop surface to the top of the marshmallow. That means the structure cannot be suspended from a higher structure, like a chair, ceiling, or chandelier.
✦**The Entire Marshmallow Must Be On Top**: The entire marshmallow needs to be on the top of the structure. Cutting or eating part of the marshmallow disqualifies the team.
*3.* ✦**Use as Much or as Little of the Kit**: Team can use as many or as few of the 20 spaghetti sticks, as much or as little of the string or tape. *The team cannot use the paper bag as part of its structure.*
✦**Break up the Spaghetti, String or Tape**: Teams are free to break the spaghetti and to cut up the tape and string to create new structures.
✦**The Challenge Lasts 18 minutes**: Teams cannot hold on to the structure when the time runs out. Those touching or supporting the structure at the end of the exercise will be disqualified.
✦**Ensure Everyone Understands the Rules**: Don't worry about repeating the rules too many times. Repeat them at least three times. Ask if anyone has any questions before starting.

**3. Start the Challenge**

Start the countdown clock and the music with the start of the challenge.

✦**Walk around the Room**: It's amazing 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 at12 minutes, 9 minutes (half-way through), 7 minutes, 5 minutes, 3 minutes, 2 minutes, 1 minute, 30 seconds and a ten-second countdown.

✦**Call Out How Teams Are Doing**: 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.

**4. Finish the Challenge**

After the clock runs out, ask everyone to sit down so they can see the structures. Just over half the teams are likely to have standing structures.

✦**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 marshmallow challenge. Discuss:

What building techniques make the tower stronger?
Does the placing of the marshmallows 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?

Tom Wujec shares findings from the Marshmallow Challenge in a 2010 TED Talk "How to Build a Power Team."

Some findings:

**Kids do Better than Business Students:** On virtually every measure of innovation, kindergarteners create taller and more interesting structures.
**Prototyping Matters:** The reason kids do better than business school students is kids spend more time playing and prototyping. They naturally start with the marshmallow and stick in the sticks. The Business School students spend a vast amount of time planning, then executing on the plan, with almost no time to fix the design once they put the marshmallow on top.

**The Marshmallow is a Metaphor for the Hidden Assumptions of a Project:** The assumption in the Marshmallow Challenge is that marshmallows are light and fluffy and easily supported by the spaghetti sticks. When you actually try to build the structure, the marshmallows don't seem so light. The lesson in the marshmallow challenge is that we need to identify the assumptions in our project – the real customer needs, the cost of the product, the duration of the service – and test them early and often. That's the mechanism that leads to effective innovation.

**Troubleshooting Tips**

Generally, a tight presentation introducing the challenge will motivate teams. Let them know this challenge has been conducted by tens of thousands of people in every continent, from top CFOs to students at all levels. The lessons learned are universal.

Goals & Rules: Be very clear about the goals and rules of the challenge. Generally, you'll want to repeat them three times and reinforce them visually.
Cheating: In almost every challenge, there is at least one team that will want to cheat or bend the rules in their favor. The clearer you are about the rules the better the results.
Prizes: Offer a prize to the winning team. A standing ovation from the rest of the group is great. Books, software, perk. But be wary of big prizes as you'll read in the Lessons of the Challenge.
Music: Select the appropriate music for the challenge. Wujec prefers driving Rock or Pop, but dramatic classical works well too.
Be clear about the goals and rules of the Marshmallow Challenge:
**Build the Tallest Freestanding Structure**: The winning team is the one that has the tallest structure measured from the tabletop surface to the top of the marshmallow. That means the structure cannot be suspended from a higher structure, like a chair, ceiling, or chandelier.
**The Entire Marshmallow Must Be On Top**: The entire marshmallow needs to be on the top of the structure. Cutting or eating part of the marshmallow disqualifies the team.
**Use as Much or as Little of the Kit**: The team can use as many or as few of the 20 spaghetti sticks, as much or as little of the string or tape. *The team cannot use the paper bag as part of its structure.*
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Read a teacher's account of doing the Marshmallow Challenge with her students, who discussed the engineering process — identifying a problem, brainstorming a solution, designing a product, testing, (failing) redesigning and retesting.

Watch the final minute of marshmallow challenge in a high school:

Filed under: Grades 6-8, Grades 9-12, Grades K-5, Lesson Plans

Tags: Class Activities, Engineering Design Process, Lesson Plan, marshmallow, marshmallow design challenge, spaghetti



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3 Responses to "Marshmallow Design Challenge"

**Judy Seidl**, on October 26th, 2011 at 8:53 am Said:

I really enjoy your ideas but find the site quite user-unfriendly. I can't print off the idea with out ended up with pages and pages. It would be GREAT if there was a concise pdf that could be used for developing a class activity – perhaps a student sheet and teacher notes. I have seen numerous ideas I would like to use or share with others but have not done so because of time constraints.

**Elaine**, on March 14th, 2012 at 4:32 am Said:

My 13 yr old enjoyed this activity at a Girl Scout STEM event & loved it. Fun!!

**steven**, on April 30th, 2012 at 10:30 am Said:

marshmallow – spaghetti project is cool!