LESSON 11:
ARCHITECTURE AND ENGINEERING

Students will design and create their own tower made of pasta and marshmallows, and see how high they can build it.

SUPPLIES

TEACHER BRINGS
- Large book
- Can of beans or corn
- Spaghetti 2 Boxes
- Marshmallow 2 bags

BIG FOLDER
- Construction Paper (a few sheets, optional)
- White Paper

MAIN BIN
- Masking Tape (4)
- Paper Plates (20)
- Ziploc
  - Toothpicks 1000

PENCIL BOX
- Tape Measure
- Pencils (20)
- Scissors (15)
- Rulers (6)
- Markers
- Clear Tape (2)
- Glue Sticks (5)

OBJECTIVES

- ☑ Students will understand the basic principles of architecture and engineering involved in constructing skyscrapers
- ☑ Design a structure that can hold It's own weight

INTRODUCTION

5-10 min

Skyscrapers began appearing about 150 years ago when cities needed more space for people to live and work. The first true skyscraper was the Home Insurance Building in Chicago, built in 1885. It was ten stories tall and used a new steel frame construction that made it both strong and light. This innovation marked the beginning of modern skyscrapers.

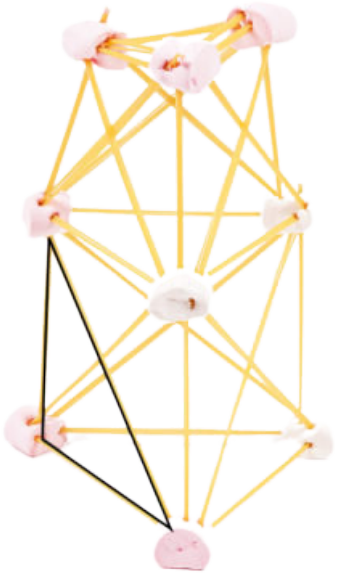
Building these towering structures comes with many challenges. Architects and engineers have to ensure that skyscrapers can withstand powerful winds and even earthquakes. They use materials like steel and concrete to make the buildings strong. They also design them in smart ways, such as making the base wider and using specific shapes that help keep the building balanced. Modern skyscrapers often have special dampers, which are large weights inside the building that move to counteract the sway from the wind.

For this project, you'll be designing your own skyscrapers using marshmallows and toothpicks. Think about how you can make your tower tall without it falling over. What shapes and designs might help?

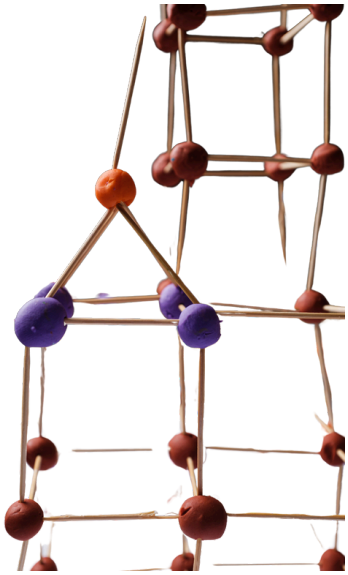
ARCHITECTURE AND ENGINEERING

DESIGN & BUILD

Some shapes are more stable than others. Before we start the experiment, try building a cube out of toothpicks and food, and then try building a pyramid. Which seems stronger: the structure made of squares, or the structure made of triangles?
Triangular shapes are especially effective, because triangles are cross-braced, which means all the weight can be supported from a single point on the top. Triangles support top and side loads much better than a square or rectangle—this is why many braces are triangular.



SPAGHETTI



TOOTHPICKS

DIRECTIONS

20-25 min

1. Before we officially start the experiment, try building a cube as a class, and then try building a pyramid. Which seems stronger: the structure made of squares, or the structure made of triangles? The goal of this experiment Is to build the tallest structure! The catch: Your tower needs to stand up on its own for 10 seconds without falling over.

2. Use toothpicks, spaghetti, and marshmallows to build a tower.
    - Let students experiment with what material they likes best!

3. Once everyone has completed a tower, measure the height, and then let It stand on its own for 10 seconds. Did It remain standing without assistance? Record your results.

4. If your structure did not stand up without falling, it is time to revisit your design! What could you have done to make it stronger and more stable? If you had to modify your original plans, record what it was that you changed.

BUILDING MATERIALS

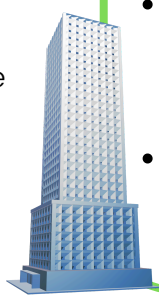
Toothpicks:

- This material is stronger and more reliable!
- However, it is much shorter and not as flexible as the spaghetti

Spaghetti:

- This material allows for builders to break it into any length they need
- However, the material is very fragile, and can't handle as much weight.

BUILDING TIP



- Start with a wide and strong base. A wider base provides better stability and helps support the height of the tower.
- Take your time and build slowly. Make sure each layer is stable before adding the next one.

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EVALUATE & REDESIGN

15-20 min

When creating structures, the design phase is important, and all architects and engineers spend lots of time figuring out what they are going to build and how they are going to build it before even starting construction. What would happen if an architect designed a building that can't support its own weight? What about a bridge that can't hold the weight of cars driving across it? Are these effective and stable designs, or are they not worth building in the first place?

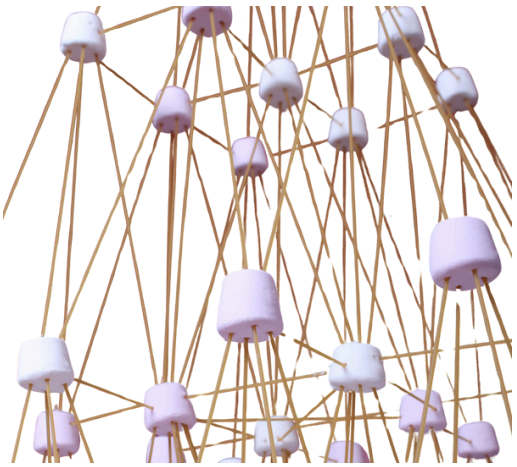
Spaghetti cannot hold much tension or compression; therefore, it breaks very easily. Marshmallows handle compression well, but do not hold up to tension. What happens when we use them together? ·Remind students to keep the ideas of tension and compression in mind when constructing their towers. Tension is created where things are pulled apart, and compression occurs when parts get pushed together. Ask at the end of the lesson if students can identify points of tension and compression in their own structures?

OBSERVE & EXPLAIN

5-7 min

Ask students to think about their designs:

- What design will allow your leaning tower of pasta to stand for 10 seconds?
  - What was difficult about the design?
  - What did you improve based on others' designs?
  - Which shapes are the best at holding weight and remaining stable?
- Ask students to identify where parts of their structure are being pushed together, and explain **compression.** Then ask them to identify parts where their structure is being pulled apart; **tension.**
  - Was your design effective?
  - Taking all of the towers into consideration: what worked best?



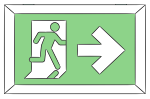
CONCLUSION

1-3 min

Tell the students that today, we thought like engineers to create tower. We went through the following stages to make our designs the best they could be:

- Brainstorming, Designing, Building, Testing, Evaluating, & Redesigning

Can students explain in their own words what they learned during the experiment?



Exit Ticket

- Q: What is the strongest shape?
  - A: Triangle