
THE EMPIRE STATE BUILDING

EDUCATION MATERIALS

SCIENCE &
TECHNOLOGY:
GRADES 6-8



SO THAT'S HOW IT WORKS:

Understanding The Science Behind The Empire State Building

OVERVIEW OF LESSON PLAN

In this lesson, students investigate a scientific or technological aspect of the Empire State Building and explain how it works.

SUGGESTED TIME ALLOWANCE

1 hour

OBJECTIVES

Students will:

- Contemplate the words “Skyscraper” and “Foundation.”
- Take part in an experiment about weight and support.
- Investigate answers to scientific or technological questions applicable to the Empire State Building.
- Create presentations that will explain how the occurrences work.

RESOURCES/ MATERIALS:

- Student journals
- Pens/pencils
- Paper
- Classroom board
- Resources on the Empire State Building, skyscrapers, engineering structure and design, science and technology textbooks
- Six cups (paper or plastic, 6-7 oz.) taped prior to class (two taped together vertically to represent one building, and four taped together vertically to represent a second)
- A ruler
- Weighted material (for example, 30 pennies or salt, sand, or soil)
- A notebook, folder, or magazine for fanning purposes

ACTIVITIES/ PROCEDURES:

Note To Teacher: Prior to class, you may choose to select questions from the list below (see Step 3) that you feel are appropriate for your students.

1) WARM-UP/DO NOW:

Ask students to create an idea bubble (or “web”) around the word “Skyscraper.” Allow a few minutes for them to write down whatever ideas they associate with skyscraper. Then ask them to create a second idea bubble for “Foundation.” When they are finished brainstorming, ask for volunteers to share. Facilitate a brief discussion on skyscrapers: why they are built, which are the most famous, what problems they might face.

2) As a class, have students answer: How does the foundation of a skyscraper work? Why doesn't a skyscraper tip over in strong winds? The class will take part in an experiment to understand how this phenomenon works.

Assemble the cups on a table, and tell the class that the following experiment will demonstrate why skyscrapers are able to remain standing.

Steps:

1. Stand the two cup buildings side by side.
2. Ask students to make a prediction about what will happen when you gently fan these two structures. Their answers are their hypotheses.
3. Standing one foot away, gently fan the structures until one falls. Do this a few times to see if this result repeats itself. Was the class' prediction correct? Ask the class how to make the taller structure stand longer.
4. Remove the tape from the bottom cup of the taller structure and add weight to it (pennies, sand, salt, or soil). What is the class' prediction now?

Repeat the experiment. (Each time you conduct the experiment, add more weight)

Ask the class to explain what happened in the experiment. Why did adding weight to the bottom cup keep the taller structure from falling over? (A skyscraper's foundation acts as an anchor to keep the building from tipping over in high winds.)

3) Divide the class into groups of four. Assign each group a question from the list below (more than one group may answer the same question):

- Will a penny thrown off of the Empire State Building make a hole in the sidewalk?
- What does it mean that the building and tower “give” in high winds?
- Why does lightning strike the Empire State Building 100 times a year? Why doesn't this affect those inside the building?
- Why do your ears pop when you are going up in the elevator? How can you ease your discomfort?
- Why don't earthquakes hit New York City?

- What kind of stone is Manhattan Island made up of that makes it strong enough to support so many skyscrapers? What other types of stones or sedimentary rock would not have been as workable?
- How does a radio or TV antenna operate? How can the Empire State Building's tower emit so many different stations' signals at once without their interfering with one another?
- Why didn't the Empire State Building collapse when a plane hit it in 1945?
- Why does snow fall upward at the top of the Empire State Building?

Using available resources, each group should research the answer to its assigned question. Groups should find or create experiments (similar to the one they just witnessed) that explain and illustrate the answers. Have groups prepare demonstrations/experiments or how-it-works posters to present the answers to their questions to the class.

Students will make their presentations in the next class.

WRAP-UP/HOMEWORK:

For homework, students should prepare their portions of the group presentation. Two students should work on the visual presentation (whether demonstration or poster), while the remaining group members write the script for the oral presentation. Each member needs to be familiar with the question's answer to participate in the Q&A session following the group presentations.

FURTHER QUESTIONS FOR DISCUSSION:

1. Of the questions being researched by the class, which do you think the designers of the Empire State Building knew the answers to before they built the building, and which do you think they found out after it was built? Why?
2. What major inventions made skyscrapers a reality? (For example, elevators)
3. To what questions about the Empire State Building would you like to find the answers?

EVALUATION/ASSESSMENT:

Students will be evaluated based on participation in the initial exercise, as well as thoughtful participation in small group research and presentation.

EXTENSION ACTIVITIES:

Powering the Empire State Building costs around \$15 million each year. What methods could be incorporated to make powering the building most cost-effective? Research alternative power sources, such as fuel cells or solar energy, which might offer a better option to a huge skyscraper like the Empire State Building. Develop a proposal that details how this energy system works, how it would be used in the building, and why it is a better option than traditional energy choices. Compare the engineering and labor techniques used to construct the Empire State Building with those used to build modern skyscrapers. Are buildings still designed and built the same way? Look at a variety of aspects of construction, from framework and lifting systems (elevators, cranes) to the use of materials such as concrete and steel. Create a presentation comparing a modern skyscraper with the Empire State Building.

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VOCABULARY:

GLOSSARY

Architect n. A person skilled in the art of building; a designer.

Disperse v. To distribute; to spread.

Engineer n. One who applies science to practical uses such as the design of structures, machines, and systems.

Force n. Strength or power exerted upon an object.

Foundation n. 1. The lowest and supporting layer of a superstructure; groundwork; basis. 2. That on which anything stands.

Gravity n. The force of attraction by which objects tend to fall toward the center of the earth.

Hypothesis n. 1. A tentative explanation for an observation, phenomenon, or scientific problem that can be tested by further investigation. 2. An educated guess.

Phenomenon n. An unusual, significant, or unaccountable fact or occurrence; a marvel.

Pressure n. The exertion of force upon a surface by an object, fluid, etc.

Sediment n. 1. The matter which subsides to the bottom, from water or any other liquid. 2. The material of which sedimentary rocks are formed.



ACADEMIC CONTENT STANDARDS:

This lesson plan may be used to address the academic standards listed below. These standards are drawn from “Content Knowledge: A Compendium of Standards and Benchmarks for K-12 Education: 3rd and 4th Editions” and have been provided courtesy of the Mid-Continent Research for Education and Learning in Aurora, Colorado.

Technology: Level III [Grade 6-8]

Standard 3. Knows ways in which technology has influenced the course of history

Benchmark 3. Knows ways in which technology has influenced the course of history

Benchmark 4. Knows that technology and science have a reciprocal relationship

Science:

Standard 10. Understands forces and motion

Benchmark 1. Understands general concepts related to gravitational force

Benchmark 3. Knows that an object’s motion can be described and represented graphically according to its position, direction of motion, and speed

Benchmark 5. Knows that an object that is not being subjected to a force will continue to move at a constant speed and in a straight line

Standard 11. Understands the nature of scientific knowledge

Benchmark 1. Understands the nature of scientific explanations

Benchmark 2. Knows that all scientific ideas are tentative and subject to change and improvement in principle, but for most core ideas in science, there is much experimental and observational confirmation

Benchmark 3. Knows that different models can be used to represent the same thing and the same model can represent different things; the kind and complexity of the model should depend on its purpose

Benchmark 4. Knows that models are often used to think about things that cannot be observed or investigated directly

Standard 12. Understands the nature of scientific inquiry

Benchmark 1. Knows that there is no fixed procedure called “the scientific method,” but that investigations involve systematic observations, carefully collected, relevant evidence, logical reasoning, and some imagination in developing hypotheses and explanations

Benchmark 2. Understands that questioning, response to criticism, and open communication are integral to the process of science)

Benchmark 3. Designs and conducts a scientific investigation

Benchmark 4. Identifies variables (e.g., independent, dependant, control) in a scientific investigation

Benchmark 5. Understands why only one variable (independent) can be manipulated at a time and that all other variables must be controlled during the investigation

Benchmark 6. Uses appropriate tools (including computer hardware and software) and techniques to gather, analyze, and interpret scientific data

Benchmark 7. Establishes relationships based on evidence and logical argument

Benchmark 8. Evaluates the results of scientific investigations, experiments, observations, theoretical and mathematical models, and explanations proposed by other scientists

Benchmark 9. Knows possible outcomes of scientific investigations