THE EMPIRE STATE BUILDING

EDUCATION MATERIALS

SCIENCE & TECHNOLOGY: GRADES 3-5

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:

- Think about the word "Skyscraper."
- Learn about the steel beams supporting the Empire State Building.
- Take part in an experiment about weight and support.
- Draw designs for their own skyscrapers.

RESOURCES/ MATERIALS:

- Student journals
- Pens/pencils
- Paper
- Classroom board
- Resources on the Empire State Building, skyscrapers, engineering structure and design
- Copies of the data collection sheet, one per student Click here for the data collection sheet
- Six cups (paper or plastic, 6-7 oz.)
- A ruler
- Weighted material (for example, 30 pennies or salt, sand, or soil)
- A notebook, folder, or magazine for fanning purposes
- A stopwatch or timer with a second hand

ACTIVITIES/ PROCEDURES:

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 the word skyscraper. Then ask for volunteers to share their ideas. Facilitate a brief discussion on skyscrapers: why they are built, which are the most famous, what problems they might face.

Ask the class the following question: “The Empire State Building weighs 365,000 tons. That is equal to the weight of over 200,000 cars! How many steel beams do you think are supporting that weight?” After students have made guesses, inform them that the answer is 210. Ask the class: “Does the number sound high or low? Where are those beams located?” (In the building’s foundation) Define the term “foundation.”

To have the class learn how a foundation works to support a building, begin by asking: “Why doesn’t a skyscraper tip over in strong winds?” Then tell the class that they will conduct an experiment to explain this phenomenon. Begin by defining what a hypothesis is.

Then assemble the six cups on a table.

Steps in the experiment:

1. Ask for three volunteers to help create “buildings” or towers out of the cups. Have one student stack and tape two cups together to make the first building; have the other two students stack and tape the remaining four cups together to make the second building (to be twice as high as the first). Stand the “buildings” side by side.
2. Hand out the data collection sheet and inform the class that you will gently fan the two structures. Ask students to each write a hypothesis (prediction) on their data sheets as to which building will fall over first.
3. Standing one foot away, gently fan the structures until one falls (start your timer when you start fanning). Do this test three or four times to see if the first result repeats itself. Students should complete their sheets each time. Were student hypotheses correct? Ask the class how to make the taller structure stand up 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 predictions now? Repeat the experiment three or four more times, each time increasing the weight incrementally (for example, add ten pennies at a time).

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.) As a class, contemplate how strong the bedrock below Manhattan is to support such structures.

Have students individually begin designs for their own skyscrapers, keeping in mind the principles they learned regarding foundation and support. They should consider the height, the number of stories, the materials, and the overall look and feel they are aiming for. If they wish to incorporate a theme (for example, one of their buildings may mimic the form of a pencil, as the Empire State Building does, or the form of a helix, or whatever they wish), they should write a description of the theme they used.

WRAP-UP/HOMEWORK:
For homework, students will complete their skyscraper designs. The drawings should have colors and a list of dimensions.

FURTHER QUESTIONS FOR DISCUSSION:
1. Can any place on Earth, any type of land, support a 365,000-ton building? Why do you think Manhattan Island can support so many skyscrapers?
2. Do you think the Empire State Building could blow over? Why or why not? (Note: It would take an estimated 4.5 million pounds of wind pressure to blow it over.)
3. In general, do you like skyscrapers, either looking at them or being in them?

EVALUATION/ASSESSMENT:
Students will be evaluated based on participation in the initial exercise, as well as thoughtful participation in the class experiment and discussion.

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.

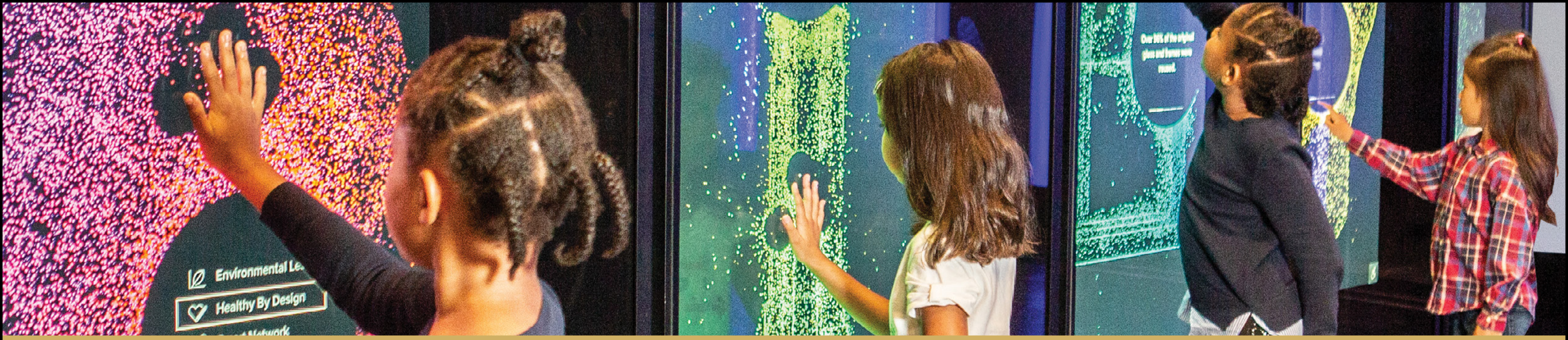
Foundation n. 1. The lowest and supporting layer of a superstructure; groundwork; basis 2. That on which anything stands.

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.

Structure n. Something constructed, such as a building.

Support v. To uphold or bear the weight of; for instance, as a pillar supports a structure.



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 II [Grade 3-5]
Standard 3. Understands the relationships among science, technology, society, and the individual
Benchmark 1. Knows that technologies often have costs as well as benefits and can have an enormous effect on people and other living things
Benchmark 2. Knows areas in which technology has improved human lives (e.g., transportation, communication, nutrition, sanitation, health care, entertainment)

Science:
Standard 11. Understands the nature of scientific knowledge
Benchmark 1. Knows that although the same scientific investigation may give slightly different results when it is carried out by different persons, or at different times or places, the general evidence collected from the investigation should be replicable by others
Benchmark 2. Knows that good scientific explanations are based on evidence (observations) and scientific knowledge
Benchmark 3. Knows that scientists make the results of their investigations public; they describe the investigations in ways that enable others to repeat the investigations
Benchmark 4. Knows that scientists review and ask questions about the results of other scientists’ work
Benchmark 5. Understands that models (e.g., physical, conceptual, mathematical models, computer simulations) can be used to represent and predict changes in objects, events, and processes
Standard 12. Understands the nature of scientific inquiry
Benchmark 1. Knows that scientific investigations involve asking and answering a question and comparing the answer to what scientists already know about the world
Benchmark 2. Knows that scientists use different kinds of investigations (e.g., naturalistic observation of things or events, data collection, controlled experiments), depending on the questions they are trying to answer
Benchmark 3. Plans and conducts simple investigations (e.g., formulates a testable question, plans a fair test, makes systematic observations, develops logical conclusions)
Benchmark 4. Uses appropriate tools and simple equipment (e.g., thermometers, magnifiers, microscopes, calculators, graduated cylinders) to gather scientific data and extend the senses
Benchmark 5. Knows that scientists’ explanations about what happens in the world come partly from what they observe (evidence), partly from how they interpret (inference) their observations
Benchmark 6. Knows the reasons why similar investigations may not produce similar results (e.g., differences in the things being investigated, methods being used, uncertainty in the observation)