THE SCIENCE OF FRINGE

EXPLORING: EARTHQUAKES

A SCIENCE OLYMPIAD THEMED LESSON PLAN

SEASON 2 - EPISODE 15: JACKSONVILLE

Overview:

Students will learn about earthquakes of different magnitudes, as well their impact on buildings and how it can be mitigated.

Grade Level: 9–12

Episode Summary:

When a building in Manhattan is destroyed in a bizarre earthquake that transports another building from the alternate dimension literally inside of it, Walter realizes that if he does not correct the unbalance created by the incident, another building of the same mass in Manhattan will vanish into the alternate dimension, along with everyone inside. With another catastrophe imminent, the team searches for an answer in Jacksonville in an effort to save hundreds of people from certain death.

Related Science Olympiad Event:

Dynamic Planet - Students will work at stations that display a variety of earth science materials and questions related to earthquakes and volcanoes.

Learning Objectives:

Students will understand the following:

- The theory of plate tectonics as it relates to earthquakes.
- How to compare different size earthquakes based upon their moment magnitude scale number.
- Ways to protect buildings and people during an earthquake.

Episode Scenes of Relevance:

- Ted and Pauline experiencing a small earthquake and discussing all the recent quakes the building has suffered
- Brandon, Peter and Walter in the Massive Dynamic Geologic Division trying to find a pattern in the microquakes throughout New York
- View the above scenes: http://www.fox.com/fringe/fringe-science

Online Resources:

- Fringe “Jacksonville” full episode: http://www.fox.com/fod/play.php?sh=fringe
- Science Olympiad Dynamic Planet event: http://soinc.org/dynamic_planet_c
- Make-a-Quake Earthquake effect on buildings simulator: http://dsc.discovery.com/guides/planetearth/earthquake/interactive/interactive.html
- Virtual Earthquake: http://nemo.sciencecourseware.org/eec/Earthquake/
- U.S. Geological Survey Earthquake FAQs: http://earthquake.usgs.gov/learn/faq/

Procedures:

1. Review with your students what they know about earthquakes and what has recently been reported in the news regarding them.
2. Tell your students that they are going to simulate an earthquake and the impact on various structures, but first they need to know more about earthquakes.
3. Have students use print research materials and the Internet to research plate tectonics and earthquake engineering of buildings.
4. Divide your class into groups. Have each group complete the following activity:
    a. Materials: small wood blocks, thin rubber bands, rulers, sandpaper, tape, paperclips, small marshmallows
    b. Tape the sandpaper to a table top with the rough side facing up.
    c. Lay the wood block on the sand paper. Align a ruler to one side of the paper, with the block at "0".
    d. Link several rubber bands together into a chain and tape one end to the block securely.
    e. Unbend several paperclips and using the marshmallows as links create a small tower to sit on the block.
    f. Pull the rubber bands away from the block slowly and note how far they stretch before the block slips, which is in indicator of the force on the block, as well as how the tower responds to the 'earthquake'.
    g. Repeat this process several times, trying different pulling techniques (i.e. slower, faster, at angles). Note the impact these have on the force required to move the block and the tower.
    h. Try different construction techniques based upon the earthquake engineering research previously done in order to build the tallest tower possible that remains standing in the simulated earthquake.
5. Lead the class in a discussion comparing results from the different groups. Tie their results back into real-world examples of plate tectonics and building designs. Example discussion topics:
    a. The rubber band stretch distance corresponding to earthquake moment magnitude
    b. The jerky nature of the block slipping corresponding to aftershocks
    c. The location of the marshmallows corresponding to the mass distribution in a building

Additional Discussion Suggestions:

- What is the difference between the Richter scale and the moment magnitude scale?
- What are the advantages and disadvantages of various seismic vibration control techniques for structures such as tuned mass dampers, roller bearings, and springs-with-damper base isolators?
- Is there any credible way to predict earthquakes?

Extension to Other Subjects:

Social Studies: Compare population density maps and seismic hazard maps and determine if there is a correlation.

Language Arts: Review and critique earthquake-related articles from news magazines and papers for hyperbole and effectiveness of communicating the science behind earthquakes.

Math: Calculate the epicenter of an earthquake based upon the time and magnitude recorded at several seismograph stations.

National Science Standards Alignment:

M.D.1 Structure of the earth system

b. Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions.

H.D.1 Energy in the earth system

b. The outward transfer of earth's internal heat drives convection circulation in the mantle that propels the plates comprising earth's surface across the face of the globe.