STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**Shake it up, Baby: Safer Buildings, Better Lives**
Economic Cluster	Advanced Manufacturing & Materials
Targeted Grades	8
STEM Disciplines	Science Technology Engineering Math
Non-STEM Disciplines	English Language Arts

Section I: STEM Unit Overview

Unit Overview

Student teams are challenged to build a cost-effective base-isolation prototype that will prevent damage to a building in the event of an earthquake. In order to effectively complete the design challenge, students will investigate the causes and effects of earthquakes by researching Earth's composition, faults, and seismic waves. Teams will then choose a design using a decision analysis matrix, sketch a schematic of the plan, and design a prototype of their base-isolation system. Students will evaluate their prototype by rigorously testing its ability to withstand various types of seismic waves and prevent building structure from collapsing in an earthquake simulator. Finally, teams will present a persuasive multimedia design proposal to the National Register of Historic Places as well as to the United States Defense Security cooperation Agency (DSCA) in hopes of having an opportunity to make a difference and serve others through winning the contract.

Essential Question

What makes an earthquake hazardous, and how do we use our understanding of geological processes to design safer structures?

Enduring Understanding

Buildings in earthquake hot-spots need to be constructed to withstand movements associated with P, S, and surface waves.
Earthquakes are caused by a shift in tectonic plates.

The earth is a dynamic planet that is constantly changing. As a result, its residents must adapt to these changes.

Presentation of knowledge and ideas is enhanced through appropriate organization and style for an audience via the use of visual displays, technology, and appropriate use of language.

Engineering Design Challenge

The National Register of Historic Places is accepting proposals for base-isolation systems to be made available for use with historic buildings. Additionally, the United States Defense Security Cooperation Agency (DSCA) is looking to partner with the National Register of Historic Places and utilize the base-isolation systems for global humanitarian relief. The base-isolation system must be cost-effective and incorporate composite materials. In order to effectively complete the design challenge, teams will need to first investigate the causes and effects of earthquakes by researching Earth's composition, faults, and seismic waves. Each team will then choose a design using a decision analysis matrix, sketch a schematic of the plan, and design a prototype of your base-isolation system. Your team will evaluate your prototype's ability to prevent buildings from collapsing by putting it through rigorous testing in an earthquake simulator. Finally, your team will present a persuasive design proposal to the National Register of Historic Places as well as to the DSCA in hopes of having an opportunity to make a difference and serve others by winning the contract

Time and Activity Overview

Day	Time Allotment	Actvities
1	50 minutes	Pretest Video: NOVA Japan Killer Quake Video: Fracking Explained Design Challenge Overview News Articles
2	50 minutes	Discuss CNN Articles Group Careers Develop Team Code of Conduct Explore Shake Table and Structure Analyze Building Scale and Occupancy Homework: Career Research (due day 4)
3	50 minutes	Guided Internet Research: *Faults: Mountain Maker, Earth Shaker *Earthquake Waves
4	50 minutes	Career Meetings / Discussion Wave Inquiry: Slinky Lab
5	50 minutes	Introduce Need for Earthquake Proofing Video Clips Explaining Base-Isolation Introduce Decision Analysis Matrix Prepare Goals for Decision Analysis Matrix Explore Materials Homework: Develop Individual Base-Isolation Design
6	50 minutes	Present Individual Design Sketches to Team Choose Design Using Decision Analysis Matrix Teams Sketch of Prototype Design Day 6 Exit Slip
7	50 minutes	Begin Constructing Prototype
8	50 minutes	Finish Prototype Construction Test Analyze, Complete Data Tables Redesign as Time Allows
9	50 minutes	Explain Proposal Teams Assign Individual Components for Proposal Completion Homework: Individual Proposal Task Completion
10	50 minutes	Compile Homework Components into Final Proposal Practice, Modify, and Begin Proposal Presentations
11	50 minutes	Finish Proposal Presentations Post-test

Pre-requisite Knowledge & Skill	layers of the earth continental drift theory plate tectonics theory causes of earthquakes basic knowledge of Excel

Academic Content Standards

Add Standard	Mathematics
Grade/Conceptual Category	8
Domain	Functions
Cluster	Use functions to model relationships between quantities
Standards	4. Construct a function to model a linear relationship between two quantities.

Add Standard	Mathematics
Grade/Conceptual Category	8
Domain	Statistics and Probability
Cluster	Investigate patterns of association in bivariate data
Standards	1. Construct scatter plots to investigate patterns 2. Informally fit a straight line to data that suggests a linear relationship. 3. Use the equation of a linear model to solve problems in the context of measurement data (i.e. - if we need the structure to withstand (Y) amount of stress, how high/large can we make the structure).

Add Standard	Mathematics
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	English Language Arts	
Grade	8	
Strand	Writing	
Topic	Research to Build and Present Knowledge	
Standard	W.8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.	

Add Standard	English Language Arts	
Grade	8	
Strand	Speaking and Listening	
Topic	Comprehension and Collaboration	
Standard	SL.8.1. Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly. ○ Come to discussions prepared, having read or researched material under study; explicitly draw on that preparation by referring to evidence on the topic, text, or issue to probe and reflect on ideas under discussion. ○ Follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles as needed. ○ Pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas. ○ Acknowledge new information expressed by others, and, when warranted, qualify or justify their own views in light of the evidence presented.	

Add Standard	English Language Arts
Grade	8
Strand	Speaking and Listening
Topic	Presentation of Knowledge and Ideas
Standard	SL.8.4. Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation. SL.8.5. Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Add Standard	English Language Arts
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	Social Studies
Grade	
Theme	
Strand (pk-8 only)	
Topic	
Content Standard	

Add Standard	Social Studies
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	Science
Grade	8
Theme	Order and Organization
Topic	Physical Earth
Content Standard	-A combination of constructive and destructive geologic processes formed Earth's surface. -Earth's surface is formed from a variety of different geologic process, including but not limited to plate tectonics.

Add Standard	Science
Grade	8
Theme	Order and Organization
Topic	Physical Earth
Content Standard	The composition and properties of Earth's interior are identified by the behavior of seismic waves. -The refraction and reflection of seismic waves as they move through one type of material to another is used to differentiate the layers of Earth's interior. Earth has an inner and outer core, an upper and lower mantle, and a crust. -The formation of the planet generated heat from gravitational energy and the decay of radioactive elements, which are still present today. Heat released from Earth's core drives convection currents throughout the mantle and the crust. Note: The thicknesses of each layer of Earth can vary and be transitional, rather than uniform and distinct as often depicted in textbooks.

Add Standard	Science
Grade	8
Theme	Order and Organization
Topic	Physical Earth
Content Standard	Earth's crust consists of major and minor tectonic plates that move relative to each other. -Convection currents in the crust and upper mantle cause the movement of the plates. The energy that forms convection currents comes from deep within the Earth. -There are three main types of plate boundaries: divergent, convergent and transform. Each type of boundary results in specific motion and causes events (such as earthquakes or volcanic activity) or features (such as mountains or trenches) that are indicative of the type of boundary.

Add Standard	Science
Strand	
Course Content	
Content Elaboration	

Add Standard	Science
Grade	
Standard	
Benchmark	
Indicator	

Add Standard	Fine Arts
Grade	
Subject	
Standard	
Benchmark	
Indicator	

Add Standard	Technology
Grade	8
Standard	Design: Students apply a number of problem-solving strategies demonstrating the nature of design, the role of engineering and the role of assessment.
Benchmark	Benchmark B: Recognize the role of engineering design and of testing in the design process.
Indicator	1. Explain how design involves a set of steps that can be performed in different sequences and repeated as needed 2. Identify how modeling, testing, evaluating and modifying are used to transform ideas into practical solutions.

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Base-Isolation Prototype Proposal
Quizzes, Tests, Academic Prompts	Pre/Post-Test Recorded Data
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Team Code of Cooperation Decision Analysis Matrix Teacher Observation
Student Self- Assessment	Team Code of Cooperation Decision Analysis Matrix Reflection

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	http://www.pbs.org/wgbh/aso/tryit/tectonics/indext.html - interactive site that allows students to explore the different types of plate boundaries and results of them shifting http://web.ics.purdue.edu/~braile/edumod/waves/WaveDemo.ppt - PowerPoint presentation about each type of earthquake wave http://earthquake.usgs.gov/research/index.php#cat21- site with descriptions and moving graphic examples of wave propagation for each type of earthquake wave http://www.youtube.com/watch?v=cavq2HFBa-U – video that presents information about the layers of the earth
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Excel or Google Spreadsheet can be used to record testing data and calculate each building's score. iSeismometer is an app that can be used to represent the x, y, and z forces associated with movements of the shake table. The data iSeismometer collects can be exported into Excel and manipulated for further analysis. http://earthquake.usgs.gov/research/index.php#cat21 – provides links to various data sets regarding national earthquakes.
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	"National Geographic: Understanding Earthquakes" http://txactive.us/index.html - information about a more environmentally friendly cement http://www.apawood.org/level_b.cfm?content=srv_newsinfo_34 – provides information and video about the world's largest shake table Internet research on STEM careers and base-isolation
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	Virtual Earthquake http://www.laep.org/target/technology/secondary/earthquakes/ - online interactive simulation of seismograph readings which allow students to determine the earthquake's epicenter and Richter magnitude. Make-a-Quake: Earthquake Simulator (http://dsc.discovery.com/guides/planetearth/earthquake/interactive/interactive.html) - students can change variables such as ground type, use of earthquake-proofing technology, and earthquake intensity then examine the post-quake results

C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Google Sketchup can be used to share ideas for initial and final designs Teams may use Web 2.0 tools such as Prezi or Google Presentation to communicate points for their design presentations.
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Description

Materials and Manufacturing Directorate
The Air Force Research Laboratory's Materials and Manufacturing Directorate develops materials, processes, and advanced manufacturing technologies for aircraft, spacecraft, missiles, rockets, and ground-based systems and their structural, electronic and optical components. Air Force product centers, logistic centers, and operating commands rely on the directorate’s expertise in materials, nondestructive inspection, systems support, and advanced manufacturing methods to solve system, expeditionary deployment, and operational challenges. (http://www.wpafb.af.mil/afrl/rx/)

Architectural Engineer
Architectural engineers apply engineering principles to the construction, planning, and design of buildings and other structures. They often work with other engineers and with architects, who focus on function layout or aesthetics of building projects. Architectural Engineering often encompasses elements of other engineering disciplines, including mechanical, electrical, fire protection, and others. The architectural engineers are responsible for the different systems within a building, structure, or complex. (http://www.tryengineering.org/become.php?major=Architectural+Engineering)

Architect
The essayist and poet Ralph Waldo Emerson called Greek architecture the "flowering of geometry." Architects blend art and science, designing structures for people, such as houses, apartments, schools, stores, malls, offices, places of worship, museums, sports stadiums, music theaters, and convention centers. Their designs must take into account not only the structure's appearance, but its safety, function, environmental impact, and cost. Architects often participate in all phases of design, from the initial consultation with the clients where the structure is envisioned, to its completion. Architects can enrich people lives by creating structures that are as beautiful to look at as they are functional to live, work, or shop in. (http://www.sciencebuddies.org/science-fair-projects/science-engineering-careers/CE_architect_c001.shtml?From=testb#natureofwork)

Civil Engineer
Civil engineers design and supervise the construction of roads, buildings, airports, tunnels, dams, bridges, and water supply and sewage systems. They must consider many factors in the design process from the construction costs and expected lifetime of a project to government regulations and potential environmental hazards such as earthquakes and hurricanes. Civil engineering, considered one of the oldest engineering disciplines, encompasses many specialties. The major ones are structural, water resources, construction, transportation, and geotechnical engineering. Many civil engineers hold supervisory or administrative positions, from supervisor of a construction site to city engineer. Others may work in design, construction, research, and teaching. (http://www.bls.gov/oco/ocos027.htm)

Structural Engineer
Structural Engineering is a specialty within Civil Engineering. Structural Engineers create drawings and specifications, perform calculations, review the work of other engineers, write reports and evaluations, and observe construction sites. A Professional Engineer's license is required in order to practice Structural Engineering. A license can be obtained only after completing a prescribed amount of education and work experience, and taking a 2-day exam. (http://www.seaonc.org/public/what/what_is.html)

Geotechnical engineer
Geological engineers solve engineering problems and design engineering systems with, on, and in geological materials, while, at the same time, protecting the environment. They might design structures in soil and rock for dams or tunnel construction. (http://www.tryengineering.org/become.php?major=Other+Engineering+Degree+Areas)

Geologist
Geologists study earth processes: Many processes such as landslides, earthquakes, floods and volcanic eruptions can be hazardous to people. Geologists work to understand these processes well enough to avoid building important structures where they might be damaged. Some geologists conduct studies that locate rocks that contain important metals, plan the mines that produce them and the methods used to remove the metals from the rocks. Many geologists are working to learn about the past climates of earth and how they have changed across time. This historical geology news information is valuable to understand how our current climate is changing and what the results might be. (http://geology.com/articles/what-is-geology.shtml)

Physicist
Physicists have a big goal in mind—to understand the nature of the entire universe and everything in it! To reach that goal, they observe and measure natural events seen on Earth and in the universe, and then develop theories, using mathematics, to explain why those phenomena occur. Physicists take on the challenge of explaining events that happen on the grandest scale imaginable to those that happen at the level of the smallest atomic particles. Their theories are then applied to human-scale projects to bring people new technologies, like computers, lasers, and fusion energy. (http://www.sciencebuddies.org/science-fair-projects/science-engineering-careers/Phys_physicist_c001.shtml?From=testb)

Geophysicist
A geophysicist is someone who studies the Earth using gravity, magnetic, electrical, and seismic methods. Some geophysicists spend most of their time outdoors studying various features of the Earth, and others spend most of their time indoors using computers for modeling and calculations. Some geophysicists use these methods to find oil, iron, copper, and many other minerals. Some evaluate earth properties for environmental hazards and evaluate areas for dams or construction sites. Research geophysicists study the internal structure and evolution of the earth, earthquakes, the ocean and other physical features using these methods. (http://earthquake.usgs.gov/learn/kids/become.php)

Carpenter

Carpenters build many things like buildings and boats from wood and other materials. They construct, erect, install, and repair structures and other fixtures. To do this, they cut, fit, and join the various materials together. Carpenters who work for a special construction contractor do only one or two things, like forming molds for concrete or building a frame. A carpenter may also work for a general building contractor. This carpenter performs many tasks, including putting in doors and windows, hanging kitchen cabinets, and installing ceilings. (http://www.bls.gov/k12/build01.htm)

Engineering Lab Technician

Engineering technicians solve technical problems. Some help engineers and scientists do research and development. They build or set up equipment. They do experiments. They collect data and calculate results. They might also help to make a model of new equipment. Some technicians work in quality control where they check products, do tests, and collect data.

Section II: STEM Lesson Plan

Title of Lesson	**Day 1: Pretest / Introduction to Unit**
Time Required	50 minutes
Materials	• Computer hooked up to LCD projector • Pre-Test (1 per student- See Appendix A & B for Key) • Engineering Design Challenge (1 per student- See Appendix C) • Design Challenge Rubric (1 per student- See Appendix D) • Design Proposal Presentation Rubric (1 per student - See Appendix E) • CNN News Article: "Fracking" (1 per student- See Appendix F & G for Key) • CNN News Article: "Earthquake-Proof Buildinig" (1 per student- See Appendix H & I for Key)

Objectives

Students will be able to describe how different strategies for creating safer buildings, including base isolation, prevent mass-casualties during earthquakes.

Students will prepare for discussion having read and researched material under study in order to stimulate a thoughtful, well reasoned exchange of ideas.

Instructional Process

1. Administer pretest
2. Share and discuss hook video, NOVA Japan Killer Quake: Chapter 1 (1m26s) & 2 (11m). http://www.pbs.org/wgbh/nova/earth/japan-killer-quake.html

(Note: If your school does not allow you to watch videos directly, you can download the video to a flash drive or to your computer using the video converter available at http://www.online-convert.com/. Select wmv as the target format and make sure Windows Media Player is installed on the computer you will be using to show the videos. If it is not, you can download it from http://windows.microsoft.com/en-US/windows/products/windows-media-player)

3. Divide students into teams of 4.
4. Present students with the Challenge Background as well as the Design Challenge and Design Proposal Presentation Rubrics so that students are aware of how skills and information throughout the unit will need to be applied by the end.
5. Assign CNN News Article handouts for homework.

Differentiation

Be mindful of the various learning modalities and levels of learner readiness when forming the teams so that they are well-balanced, heterogeneous groups.

For students in need of accommodations for reading and/or writing on the Pre-Test, verbal answers could be allowed in place of written answers for short answers questions, short answer questions requiring two parts could be changed to require only one response, or the student could be paired up with an adult or peer who could read each question aloud.

For students in need of accommodations for reading and/or writing for the CNN news article homework, short answer questions could be changed into clozed statements in which students only have to fill in deleted words and phrases for their answers.

Assessments	Use the Pre-Test as a summative assessment of students' prior knowledge regarding the content. Modify this unit of instruction using the results of the Pre-Test as a guide. CNN News article handout responses

Section II: STEM Lesson Plan

Title of Lesson	**Day 2: Team Code of Cooperation and Exploration of Roles and Shake Table**
Time Required	50 minutes
Materials	• CNN News articles homework and answer keys (see Appendix F & H) • Team Careers chart (1 per student- see Appendix J) • Team Code of Cooperation (1 per team- see Appendix K) • Tips for Successful Team Work (Optional 1 per team - see Appendix L) • Individual Career Position Research Guide (1 per student- see Appendix M) • Analyzing Building Scale and Occupancy (1 per student- see Appendix N & O for Key) • Shake table (at least 1 per class - **Teacher needs to have constructed prior to the lesson; see Appendix DD for instructions.) • Smart Device (iPod Touch, iPhone, Droid, etc.) with iSeismometer App installed (1 per team or class, depending on student/teacher access) • 1 class model of building (at least 1 per class - **Teacher needs to have constructed prior to the lesson; see Appendix EE for instructions)
Objectives	Students will work with peers to set rules for collegial discussions and decision-making, and assign individual roles based on strengths. Students will use the Internet to research and gather information regarding STEM career positions and organize their findings into a mind map or poster.
Instructional Process	1. Discuss the questions and answers for the CNN News article handout the students completed for homework the previous night. 2. Distribute copies of the Team Career Positions and allow teams time to assign careers based on individual strengths. Be sure to explain that the responsibilities listed for any given career position do not solely belong to the individual who takes on the position; all team members are expected to support and collaborate with their teammates as needed. 3. Allow time for students to set rules for team collaboration using the Code of Cooperation handout. 4. Show the class the shake table that will be used to test their base isolation prototypes and demonstrate how to attach the smart device with and run the iSeismometer app to the “Earth’s ground." Call teams up individually to explore the shake table using the class adobe building model while the rest of the teams select careers and complete Codes of Cooperation. Encourage students to observe and take notes on the affect the shake table has the adobe building without base isolation protection.

5. Instruct teams to complete Analyzing Building Scale and Occupancy handout when not exploring the earthquake simulating shake table. If needed, this can be finished for homework once adobe measurements are taken.
6. Near the end of class after all teammates have selected a career, distribute the Individual Career Position Research Guide. Explain that each student will use the research ideas and the Internet to find information regarding the career that matches his/her team career and then incorporate the information into a mind (concept) map or small poster to share for homework. Homework will not be needed until Day 4 of the unit.

Differentiation	For students that may struggle with the research and/or creation of a mind (concept) map, the teacher can provide a list of two or three reliable websites (or printed content) with information written at an appropriate reading level. Alternatively, the teacher could select a limited number of specific categories for the student to research, or help the student select a limited number of categories from the list. If possible, students could also be paired with a peer to assist them. Printed information packets will have to be provided for students without access to the internet, or, time may be given for those students to complete their research on school computers.
Assessments	Code of Cooperation Career Position Mind map or poster

Section II: STEM Lesson Plan

Title of Lesson	**Day 3: Guided Internet Research: Faults and Earthquake Waves**
Time Required	50 minutes
Materials	• Computers with access to the Internet (1 per 1-2 students if possible, or 1 per team) • Guided Internet Research: Faults (1 per student-see Appendix P & Q for Key) • Guided Internet Research: Earthquake Waves (1 per student-see Appendix R & S for Key)
Objectives	Students will be able to identify the locations, specific movements, events (i.e. earthquakes or volcanic activity), and features (i.e. mountains or trenches) associated with divergent, convergent, and transform faults. Students will use a variety of Internet resources in order to define body waves and surfaces waves and explain how each wave travels. Students will be able to classify primary, secondary, Love, and Rayleigh waves as either body waves or surface waves and describe the motion and resultant ground motion of each type of wave.
Instructional Process	1. Instruct students to complete guided Internet research using the “Mountain Maker, Earth Shaker” website and accompanying handout titled Guided Internet Research: Faults. 2. When students have completed their research on faults, Instruct them to complete the Guided Internet Research: Earthquake Waves handout and respond to each prompt or question using the indicated websites. Point out that students will need to understand primary and secondary waves for designing an effective prototype and creating a strong proposal presentation.
Differentiation	Students finishing quickly and needing more challenge may be asked to research how the different types of seismic waves have been used to determine the composition and properties of Earth’s interior. Students could give a verbal report or create a product to show their understanding. Students struggling with the research assignment can be paired with a peer or given cloze statements to complete.

Assessments	Guided Internet Research: Faults responses Guided Internet Research: Earthquake Waves responses

Section II: STEM Lesson Plan

Title of Lesson	**Day 4: Career Meetings and Wave Inquiry Lab**
Time Required	50 minutes
Materials	• Student mind maps or posters on career positions completed as homework from Day 2. • Tape or staples to hang maps and posters on the wall or bulletin board • Tips for Successful Group Discussions (optional; 1 per student- see Appendix I) • iSeismometer App & Slinky Inquiry: Simulating Earthquake Waves (1 per student- see Appendix T & U for Key) •Smart phone or device (iPhone, iPod Touch, Droid, etc.) with iSeismometer App • Slinky (1 per team)
Objectives	Students will engage in a small group collaborative discussion and share research on their career positions, practicing their speaking skills (i.e. making appropriate eye contact, clear pronunciation, talking at appropriate speed and volume).
Instructional Process	1. Jigsaw students according to their team career position (all students with the same position are together). Allow 5-10 minutes for students to share information on their mind maps or posters with the team. Students may add new information to their mind map or poster as others present. Ask students to practice their listening and speaking skills within their team and for teammates to give brief constructive feedback following each mind map or poster presentation. Point out that this practice will help prepare students for achieving strong scores for the individual portion of the Proposal Presentation. 2. Allow students to post their mind maps or posters in the classroom so that students have the opportunity to view information about careers other than their own. 3. Handout one Slinky to each team. 4. Instruct students to complete the iSeismometer App & Slinky Guided Inquiry: Simulating Earthquake Waves handout with their team. Remind them to make sure that each team member is able to experience each type of wave.
Differentiation	Students needing extra challenge may time how long each wave takes to travel from one person to the next and back again (total of 12 m) for 3 trials and calculate the speed using the formula: Speed = Distance/Time (S = D / T). Struggling students can be paired with a peer for guidance.

Assessments	Teacher observation during small group presentations Earthquake Wave Inquiry Lab handout responses

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Section II: STEM Lesson Plan

Title of Lesson	**Day 5: Understanding Base-Isolation and Decision Analysis**
Time Required	50 minutes
Materials	• Computer hooked up to LCD projector • Itemized Budget Sheet (1 per student - see Appendix V) • Preparing Goals for a Decision Analysis Matrix (1 per team - see Appendix W) • Decision Analysis Matrix (1 per team - see Appendix X) • Decision Analysis: Teacher Instructions (1 per teacher or per team - see Appendix Y) • Design Challenge Rubric (from Day 1) • Start Up Building Kit (1 per team - see Itemized Budget Sheet Appendix V) **Itemized Budget Sheet includes a list of possible materials, this sheet may be modified based on materials available to teacher.** • Optional Building Materials (enough for different teams to “buy” multiple materials of a kind- see Itemized Budget Sheet - Appendix V) • Choosing a Prototype Design (1 per student- see Appendix Z)
Objectives	Students will follow rules for collegial discussions and decision making to determine design constraints and objectives and rate them according to importance to create a team Decision Analysis Matrix. Students will apply their understanding of base-isolation technology and seismic waves in order to sketch an individual base-isolation design plan and explain how their envisioned idea will work to sustain the model adobe building as it is tested in multiple ways. Students will employ estimation strategies to find an estimated cost for their individual design plans.
Instructional Process	1. Introduce the need for earthquake proofing structures by showing NOVA’s Deadliest Quakes, Chapter 7: “Earthquake Proofing” http://video.pbs.org/video/1690329036/ (12m23s) 2. Show students video clips that explain and show examples of base-isolation. - Portland Court House Part 2: http://www.youtube.com/watch?v=8OVDKZB9r1Q (3m33s) - New Bridge Earthquake Test: http://www.youtube.com/watch?v=MjuTUCiyqv8 (2m) - China Basin Structural Video: http://www.youtube.com/watch?v=phgdkqn9aTI (1m58s)

3. Explain the purpose of a decision analysis matrix and the steps for creating one using the example of a college student buying a car. (Read "Teacher Instructions for Decision Analysis Techniques in Engineering Design: Method of Weighted Factors" in Appendix X prior to teaching lesson).
4. Allow students to meet in their teams in order to complete the "Preparing Goals for a Decision Analysis Matrix" handout. Direct students to refer to the Design Challenge Rubric given on Day 1 to help stimulate ideas and ensure requirements for desired level of performance are being met. As directed on the handout, the student with the role of Architectural Engineer will then record each constraint, objective, and weight on the team Decision Analysis Matrix Worksheet. Instruct all students to record the constraints and objectives that is written into the matrix so that they can refer to the list while completing their individual design plan sketches for homework.
5. Distribute Choosing a Prototype Design handout and the Itemized Budget Sheet to each student. Call teams up individually to silently examine the start up kit and optional materials that will be available to them for use while constructing their design while other teams are working to complete the Decision Analysis Matrix.
6. Assign individual base-isolation design plan sketches for homework. Instruct students to follow all directions included in bullet points under Number 2 in the "Individual Base-Isolation Design Plans" section of the "Choosing a Prototype Design" handout.

Differentiation

Students needing more challenge can be required to draw their design sketches to scale (approximating any unknown measurements).

Some students may need to have the requirements of the individual design plan reduced. For example, requiring an explanation of how the design meets only one or two goals set on the Decision Analysis Matrix, or eliminating the need to write out an explanation of how the design will help sustain the adobe as it experiences each type of seismic wave.

Assessments

Team Decision Analysis Matrix
Individual Design Plan Sketch

Title of Lesson **Day 6: Selecting a Team Prototype Design**

Time Required 50 minutes

Materials
- Individual Design Plan Sketches students completed for homework
- Team Decision Analysis Matrixes (from Day 5)
- Choosing a Prototype Design handouts (from Day 5)
- Tips for Successful Group Discussions handouts (from Day 4, optional)
- Teams' Code of Cooperation (from Day 2)
- Itemized Budget Sheets (from Day 5)
- Design Challenge Rubric (from Day 1)
- Proposal Presentation: Group Presentation Directions and Rubric (from Day 1)
- Day 6 Exit Slips (1 per student- See Appendix AA)
- Building Materials from Day 5 (start-up kit contents and additional materials available for purchase as identified on Itemized Budget Sheet)

Objectives

Students will evaluate multiple designs using a decision analysis matrix and explain the purpose and function of a prototype in the design process while collecting data on its effectiveness and suggesting improvements.

Teams will follow rules for collegial discussion and decision-making, pose questions about team members' ideas, and acknowledge new information expressed by others.

Students will compute an itemized, estimated cost for building a prototype that follows the team design plan that includes sales tax.

Instructional Process

1. Discuss the importance of brainstorming, designing, and constructing a prototype for the purpose of testing and redesign as part of the engineering design process.
2. Instruct students to follow the directions provided on the Decision Analysis Matrix sheet and bottom half of the Choosing a Prototype Design handout. (All teammates present their designs, then all designs are scored according to how well they meet each goal, and finally the team selects a design.) Emphasize the point made in Step 3: that sometimes the highest scoring design is not necessarily always the best choice and that the team also has the option of combining best features of two or more designs to create a composite design. Also, remind students of the Tips for Successful Group Discussions and the anticipated goals they created in their team Codes of Cooperation as they present, score, and select designs.
3. Once teams have selected a final design they want to proceed forward with,

instruct them to follow all of the directions in Step 4 of the Choosing a Team Prototype Design procedure. (Designs can be hand drawn, or, if students are familiar with how to use Google SketchUp and the program is downloaded to enough computers, a 3D model can be created using SketchUp). Encourage teams to refer to the Design Challenge Rubric to ensure they are meeting requirements for desire performance.

4. When checking over a team's schematic, verify that the design meets all constraints of the engineering design challenge.
5. If a team completes all parts of the team design plan early and receives teacher approval, the members may begin purchasing materials and constructing their prototypes. Students must bring up an itemized budget sheet and record the name, unit price, quantity, and total price of each material they wish to purchase.
6. If time permits, ask students to reflect on the use of the Decision Analysis Matrix, including benefits.
7. Assign the Day 6 Exit Slip as homework.

Differentiation

Requiring that the team design be drawn to scale increases the challenge level of the assignment.

Struggling students can be paired with a peer for guidance.

Assessments

Team Decision Analysis Matrixes
Individual Design Plan Sketches
Prototype Design Sketch
Day 6 Exit Slip

Section II: STEM Lesson Plan

Title of Lesson

Days 7 and 8: Prototype Construction and Testing

Time Required

50 minutes

Materials

- Team Design Plans (from Day 6)
- Itemized Budget Sheets (from Days 5 & 6)
- Engineering Challenge Rubric (from Day 1)
- Tips for Successful Group Discussions handouts (from Day 4 , optional)
- Teams' Code of Cooperation (from Day 2)
- Building Materials (from Days 5 & Start-Up kit contents and additional materials available for purchase as identified on Itemized Budget Sheet)
- 2 large binder clips
- 2 large bulldog clips
- Shake table(s) (from Day 2)
- Model adobe house(s) (from Day 2)
- Smart device with iSeismometer app installed
- Rubber band
- Earthquake Sustainability Data Sheet and Reflection handouts (1 per team- see Appendix BB)
- Prototype Analysis and Reflection handouts (1 per team- see Appendix CC)
- Devices capable of taking video to record testing such as cell phone, digital camera, flip camera, etc. (optional)

Objectives

Students will apply methods and tools of inventive problem-solving to build a base-isolation prototype, test design concepts and make modifications to improve its performance based on analysis of testing data.

Students will apply their knowledge of seismic waves to identify which type of waves is most likely being represented by the motion of the shake table.

Students will compute the total cost of the materials required for the research and development of their team prototype, including sales tax.

Instructional Process

1. If necessary, allow teams to complete the team design plan requirements and approve the plans.
2. As stated in Day 5 instructions, after a team completes all parts of the team design plan and receives teacher approval, the team may begin recording materials used on the Itemized Budget Sheet and constructing prototypes. Students must bring up an itemized budget sheet and record the name, unit price, quantity, and total price of each material they wish to purchase show the teacher.

(Note: Students may return materials they decide not to use only if they are still in "new" condition.)

3. After finishing prototype construction according to design plan, teams may attach the adobe building model to it and begin testing the base isolation's effectiveness on the shake table. Directions for testing the base isolator can be found in Appendix EE. As students test their prototypes, they should record testing data on the Earthquake Sustainability Data Sheet. Every team should experience the opportunity to modify and retest at least once. Each time a team tests a revised design, data must be recorded.
4. Remind teams that they must continue to add the name, unit cost, total number, and total cost of any additional materials they need during the redesign stage on the Itemized Budget Sheet.
5. Encourage students to reference the Design Challenge Rubric during their construction and testing to be sure they are meeting requirements for their desired level of performance. Similarly, students should refer to the rubric for the Proposal Presentation for the same reason. For example, if recording equipment of some kind is available, students may want to record their testing on video to be able to integrate multimedia effectively into their presentations.
6. During the last 10-15 minutes of Day 8, distribute one Prototype Analysis and Reflection sheet to the team and allow the students to collaboratively answer each question or prompt.

Differentiation

Struggling students can be paired with a peer for guidance.

Student teams in need of a challenge could be asked to determine what real-world materials could be used to actually build their design for a real adobe building and provided an estimated cost for their envisioned designs.

Student teams who create a prototype that passes each trial described for the testing process could be asked to evaluate the plausibility of the effectiveness of their design in the real world and argue for or against it.

Assessments

Itemized Budget Sheets- Actual Prototype Cost
Prototype
Earthquake Sustainability Data Sheet and Reflections
Prototype Analysis and Reflection handouts

Section II: STEM Lesson Plan

Title of Lesson	**Days 9 and 10: Proposal Presentations**
Time Required	50 minutes
Materials	• 1 computer with Internet access for real-time collaboration within web2.0 presentation freeware (Prezi.com, Google Docs Presentation, etc.) (1 per person in order for team to create presentations on simultaneously (each team may work together on 1 computer if computers availability is limited) • 1 computer hooked up to an LCD projector • Video, pictures, and/or voice recordings (for example, a podcast) that document any part(s) of the team engaging in the engineering design process. • Design Proposal Presentation Rubric (from Day 1)
Objectives	Students will integrate multimedia and visual displays into web2.0 presentations to clarify information, strengthen claims and evidence, and add interest. Students will follow rules for collegial discussions and decision-making, track progress toward specific goals and deadlines, and define individual roles, as needed in order to complete proposal presentation. Students will present claims and findings regarding their engineered base-isolation systems, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
Instructional Process	1. Explain the purpose and requirements of the Proposal Presentation. Refer students to the Group Proposal Presentation Directions and Rubric and Individual Proposal Presentation Rubric received on Day 1. Instruct teams to divide the assignment into tasks that each teammate will be responsible for in class as well as finishing for homework on Day 9. 2. Remind students to complete their proposal homework as assigned within the team. Stress that failure to complete the homework as agreed will result in an incomplete team proposal presentation. 3. At the start of Day 10, direct teams to practice their presentations after reviewing and editing their final project that was completed for homework. 4. Begin class presentations. Score each group's presentation according to the Group Presentation Rubric and score each student's speaking skills individually using the Individual Presentation Rubric.

Differentiation	Struggling students can be paired with a peer for guidance.
Assessments	Proposal Homework Group Presentation Rubric Individual Presentation Rubric

Section II: STEM Lesson Plan

Title of Lesson	**Day 11: Unit Wrap Up**
Time Required	50 minutes
Materials	• Computer hooked up to an LCD projector and any other materials teams need for Proposal Presentations • Proposal Presentation: Design Presentation Directions and Rubric (teacher needs one for each team presenting for grading purposes- See Appendix D) • Post-Test (1 per student- See Appendix A & B for Key)

Objectives

Students will present claims and findings regarding base-isolation systems, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Students will pose questions that connect the ideas of several speakers and respond to others' questions and comments with relevant evidence, observations, and ideas.

Instructional Process

1. Continue Proposal Presentations. Again, score the group's presentation according to the Group Proposal Presentation Rubric and score each student's speaking skills individually using the Individual Presentation Rubric.
2. After all the groups have presented their proposals, administer the Post-Test.
3. If time permits or as homework, allow students to reflect and debrief about their experiences and learning throughout the unit. Some sample questions you might ask include:
   - -What were the students' favorite and least favorite parts?
   - -What did they find especially challenging or easy?
   - -What were the students surprised by?
   - -What is the greatest lesson they will take away from this unit (this question is meant to be wide open- students should feel free to write something they've learned that is science related, engineering, something about themselves or others, etc.)
   - -How would they improve the unit if they were teaching it?
   - -What advice can they offer for future students who will complete this challenge?

Differentiation	For students in need of accommodations for reading and/or writing on the Post-Test, verbal answers could be allowed in place of written answers for short answers questions, short answer questions requiring two parts could be changed to require only one response, or the student could be paired up with an adult or peer who could read each question aloud. Some students may need notes to reference during the presentation.
Assessments	Group Proposal Presentation Rubric Individual Proposal Presentation Rubric Post-Tests

Materials and Resource Master List

Printable Resources

Per Team or Per Class (depending on teacher/student access):
-Smart Device (iPod Touch, iPhone, Droid, etc.) with iseismometer App installed

Per Team:
-Start-Up Building Kit:
1 pair scissors,
4 unsharpened pencils
6 glass marbles, 6 drinking straws,
1 cubic cm of modeling clay
20 cm x 20 cm corrugated cardboard sheet
30 cm x 30 cm cardboard sheet

-Additional Building Materials from Itemized Budget (see Appendix A) (enough for teams to budget multiple materials). The following list may be edited based on individual teacher preferences and supply availability:
Aluminum foil (2 cm x 5 cm pieces)
Ball bearings (large and small)
Balloons
Bouncy balls (large and small)
Canning jar lids
Canning jar rings
Clay (cut into approximately 1 cubic centimeter cubes)
Duct tape
Magnets
Marbles
Plastic bottles
Rubber bands (large and small)
Rubber sections
Springs (large, medium, and small)
Straws
Pencils
Shower curtain rings

Shake Table:
-1 30 cm X 30 cm square piece of plywood
-16 2" wood screws
-1 package heavy-duty rubber bands
-1 8' long, slab grade, 2" x 4" piece of lumber

Adobe House:
-24 Jenga® game blocks

-1 lb. package of clay (gray and brown are recommended for making the most realistic looking bricks)
-1 roll of nonskid shelf paper
-1 can spray adhesive
-2 large binder clips
-2 large bulldog clips
-1 10 cm X 10 cm square of corrugated cardboard
-1 20 cm X 20 cm square of ¼" thick wood or pegboard

Key Vocabulary

base-Isolation
see "seismic-isolation"

centrifugal force
an outward force on a body rotating about an axis, assumed equal and opposite to the centripetal force and postulated to account for the phenomena seen by an observer in the rotating body. (The American Heritage® New Dictionary of Cultural Literacy, Third Edition, n.d.)

convection - the transfer of heat by the circulation or movement of the heated parts of a liquid or gas. (The American Heritage® New Dictionary of Cultural Literacy, Third Edition, n.d.)

composite materials - are the combination of two or more materials to reinforce their properties and make them stronger together than they are apart (American Composites Manufacturers Association ACMA: for consumers, buyers & end users - what is composites, n.d.)

damper
one that deadens, restrains, or depresses. A device that eliminates or progressively diminishes vibrations or oscillations, as of a magnetic needle. (http://www.thefreedictionary.com/damper)

earthquake
term used to describe both sudden slip on a fault, and the resulting ground shaking and radiated seismic energy caused by the slip, or by volcanic or magmatic activity, or other sudden stress changes in the earth. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

epicenter
point on the earth's surface vertically above the hypocenter (or focus), point in the crust where a seismic rupture begins. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

fault
fracture along which the blocks of crust on either side have moved relative to one another parallel to the fracture. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)
focus
point within the earth where an earthquake rupture starts; also referred to as hypocenter. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)
gravitational force
attraction between two masses, such as the earth and an object on its surface. Commonly referred to as the acceleration of gravity. Changes in the gravity field can be used to infer information about the structure of the earth's lithosphere and upper mantle. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

intensity - a number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures. Several scales exist, but the ones most commonly used in the United States are the Modified Mercalli scale and the Rossi-Forel scale. There are many intensities for an earthquake, depending on where you are, unlike the magnitude, which is one number for each earthquake. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

liquefaction
a process by which water-saturated sediment temporarily loses strength and acts as a fluid, like when you wiggle your toes in the wet sand near the water at the beach. This effect can be caused by earthquake shaking. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

love wave
a surface wave having a horizontal motion that is transverse (or perpendicular) to the direction the wave is traveling; also referred to as L-wave. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

magnitude
a number that characterizes the relative size of an earthquake. Magnitude is based on measurement of the maximum motion recorded by a seismograph. Several scales have been defined, but the most commonly used are (1) local magnitude (ML), commonly referred to as "Richter magnitude," (2) surface-wave magnitude (Ms), (3) body-wave magnitude (Mb), and (4) moment magnitude (Mw). Scales 1-3 have limited range and applicability and do not satisfactorily measure the size of the largest earthquakes. The moment magnitude (Mw) scale, based on the concept of seismic moment, is uniformly applicable to all sizes of earthquakes but is more difficult to compute than the other types. All magnitude scales should yield approximately the same value for any given earthquake. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

primary wave
a seismic body wave that shakes the ground back and forth in the same direction and the opposite direction as the direction the wave is moving; also know as a P-wave, or compressional wave. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

plate tectonics
the theory supported by a wide range of evidence that considers the earth's crust and upper mantle to be composed of several large, thin, relatively rigid plates that move relative to one another. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

rayleigh wave
a seismic surface wave causing the ground to shake in an elliptical motion, with no transverse, or perpendicular, motion. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

richter magnitude scale
was developed in 1935 by Charles F. Richter of the California Institute of Technology as a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes. On the Richter Scale, magnitude is expressed in whole numbers and decimal fractions. For example, a magnitude 5.3 might be computed for a moderate earthquake, and a strong earthquake might be rated as magnitude 6.3. Because of the logarithmic basis of the scale, each whole number increase in magnitude represents a tenfold increase in measured amplitude; as an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

"Ring of Fire"
the zone of earthquakes surrounding the Pacific Ocean- about 90% of the world's earthquakes occur there. The next most seismic region (5-6% of earthquakes) is the Alpide belt (extends from Mediterranean region, eastward through Turkey, Iran, and northern India); also called the Circum-Pacific belt. (U.S. Department of the Interior/ U.S. Geologlical Survey, n.d.)

sea-floor spreading
what happens at the mid-oceanic ridge where a divergent boundary is causing two plates to move away from one another resulting in spreading of the sea floor. As the plates move apart, new material wells up and cools onto the edge of the plates. (http://earthquake.usgs.gov/learn/glossary)

secondary wave
a seismic body wave that shakes the ground back and forth perpendicular to the direction the wave is moving; also known as S or shear wave. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

seismic isolation system
is a collection of structural elements that should substantially decouple a structure from the horizontal components of ground shaking thus protecting the building's integrity; also known as base- isolation. (Base isolation: promise, design & performance, n.d.)

seismic - relating to an earthquake or to other tremors of the Earth, such as those caused by large explosions. (The American Heritage® Science Dictionary, n.d.)

seismic wave
an elastic wave generated by an impulse such as an earthquake or an explosion. Seismic waves may travel either along or near the earth's surface (Rayleigh and Love waves) or through the earth's interior (P and S waves). (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

seismogram
a record written by a seismograph in response to ground motions produced by an earthquake, explosion, or other ground-motion sources. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

seismograph
is an instrument used to detect and record earthquakes. Generally, it consists of a mass attached to a fixed base. During an earthquake, the base moves and the mass does not. The motion of the base with respect to the mass is commonly transformed into an electrical voltage. The electrical voltage is recorded on paper, magnetic tape, or another recording medium. This record is proportional to the motion of the

seismometer mass relative to the earth, but it can be mathematically converted to a record of the absolute motion of the ground. Seismograph generally refers to the seismometer and its recording device as a single unit. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

seismometer
see “seismograph”

subduction - the process of the oceanic lithosphere colliding with and descending beneath the continental lithosphere. (U.S. Department of the Interior/U.S. Geologlical Survey, n.d.)

Technical Brief

An earthquake is described as the sudden shifting or movement of rock in the earth’s crust. The earth is made up of three distinct layers: crust, mantle and core. The crust is the thin outermost layer that is composed of solid rock. Just below the crust is the mantel which is made up of an upper region (denser solid rock) and a lower region (molten rock). Descending further, the temperature continues to increase due to higher pressures and you reach the center of the earth called the core. This layer is composed of a liquid outer layer and a solid metallic inner core that is very dense.[1]

The solid rock found in both the crust and the upper region of the mantel form large tectonic plates that float on top of the heavier molten rock. These plates are constantly moving over, under, alongside, or apart from one another due to convection, gravitational forces, and centrifugal forces. As these tectonic plates move against each other, they stick or jam causing stretching or compression in the rocks that are touching. At some point, a huge amount of energy builds up to the breaking point causing a sudden movement along the edges or fault lines of these tectonic plates. The seismic waves from this sudden release of energy shoot out in all directions that radiate up through the crust to the earth’s surface.

There are three basic types of elastic waves that cause the earth to shake and cause damage: longitudinal or primary (P waves), transverse or secondary (S waves), and surface waves (Love and Rayleigh waves). (U.S. Department of the Interior/U.S. Geological Survey, 2009) The P waves are felt first because they travel faster. These waves are sometimes referred to as compressional waves because they alternate between compression and expansion in the material along the same direction it is traveling. These waves are able to travel through both solid rock and liquid material (water and molten lava). A few seconds later, the S waves are felt next because they travel slower than P waves. Since they travel at right angles, they create up-and-down and side-to-side motion which moves the ground surface vertically and horizontally. It’s this side-to-side type of wave motion that is so damaging to buildings and structures. The third type of earthquake wave is called a surface wave because its motion is restricted to near the ground surface. These waves resemble the ripples of water that travel across a lake when a pebble is thrown into it.

Scientists and engineers use seismometers to measure the strength or magnitude of these elastic waves. Since the magnitude can jump several orders of magnitude, a Richter scale was developed to compare the intensity of these earthquakes. So a magnitude 2 is 10 times stronger than a magnitude 1 and a magnitude 3 is 100 times stronger than a magnitude 1. The largest earthquake that has been recorded using a seismograph reached 9.5 magnitude. This occurred on 22 May 1960 near Cañete, Chile. (U.S. Department of the Interior/U.S. Geological Survey, 2011) One of the most devastating earthquakes recorded in history occurred on 23 January 1556 in the Shaanxi province in China. This particular earthquake reportedly killed more than 830,000 people that lived in caves and cliffs that were not built to withstand the side-to-side motion created with a seismic wave. (Earthquakes with 50,000 or more deaths, n.d.) What's important to note here is that earthquakes don't kill people, buildings kill people. That's because a lot of buildings are built to withstand heavy loads rather than side-to-side motions. The purpose of this lesson is to teach students how to build structures that will withstand the force of an earthquake and prevent it from collapsing. Different foundations and building materials can be used to make the structure lighter, stronger and more flexible. Understanding how an earthquake is generated, the geographical location and surrounding environment, along with new technologies in materials and reinforcement will help students to better understand how to build structures that are earthquake-proof.

Safety and Disposal

It is recommended that:
-students work with sharp objects only with adult supervision.
-students wear goggles when working with springs, rubber bands, and testing on the shake table.

Most materials used in this unit are reusable. However, should something need to be disposed of, it is recommended that items be recycled or disposed of in appropriate waste receptacles.

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