TURNING IDEAS INTO REALITY:
ENGINEERING A BETTER WORLD

Save the Building

Targeted Grades
4, 5, 6, 7, 8

STEM Career Connections
Chemical Engineering
Civil Engineering
Architecture and Construction

STEM Disciplines
Science
Technology
Engineering

Non-STEM Discipline
English Language Arts

Academic Content Standards

Ohio's New Learning Standards: Science Cognitive Demands
Expectations for Learning Cognitive Demands K-12
Designing Technological / Engineering Solutions Using Science Concepts: Requires student to solve science-based engineering or technological problems through application of scientific inquiry. Within given scientific constraints, propose or critique solutions, analyze and interpret technological and engineering problems, use science principles to anticipate effects of technological or engineering design, find solutions using science and engineering or technology, consider consequences and alternatives, and/or integrate and synthesize scientific information.
Demonstrating Science Knowledge: Requires student to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather and organize data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments.
Interpreting and Communication Science Concepts: Requires student to use subject-specific conceptual knowledge to interpret and explain events, phenomena, concepts and experiences using grade-appropriate scientific terminology, technological knowledge and mathematical knowledge. Communicate with clarity, focus and organization using rich, investigative scenarios, real-world data and valid scientific information.

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Expectations for Technology and Engineering Design: Guiding Principles Grades PreK-8

Technological Design:

Technological design is a problem or project-based way of applying creativity, science, engineering and mathematics to meet a human need or want. Modern science is an integrated endeavor. Technological design integrates learning by using science, technology, engineering and mathematics and fosters 21st Century Skills.

Technology and Engineering:

Technology modifies the natural world through innovative processes, systems, structures and devices to extend human abilities. Engineering is design under constraint that develops and applies technology to satisfy human needs and wants. Technology and engineering, coupled with the knowledge and methods derived from science and mathematics, profoundly influence the quality of life.

Examples of the grade-appropriate skills expected of students:

PreK-4:

- Identify problems and potential technological/engineering solutions
- Understand the design process, role of troubleshooting
- Understand goals of physical, informational and bio-related technologies
- Understand how physical technologies impact humans

Grades 5-8:

- Understand and be able to select and use physical and informational technologies
- Understand how all technologies have changed over time
- Recognize role of design and testing in the design process
- Apply research, innovation and invention to problem solving

Ohio's New Learning Standards: Science Guiding Principles Grades 3-8

There is no science without inquiry. Scientific inquiry is a way of knowing and a process of doing science. It is the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas as well as an understanding of how scientists study the natural world.
Teachers need to model scientific inquiry by teaching with inquiry.

Grades 3-5:

During the years of PreK-4, all students must become proficient in the use of the following scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas:

- Observe and ask questions about the natural environment;
- Plan and conduct simple investigations;
- Employ simple equipment and tools to gather data and extend the senses;
- Use appropriate mathematics with data to construct reasonable explanations;
- Communicate about observations, investigations and explanations; and
- Review and ask questions about the observations and explanations of others.

Theme: Interconnections within Systems

This theme focuses on helping students explore the components of various systems and then investigate dynamic and sustainable relationships within systems using scientific inquiry.

Grades 6-8:

During the years of grades 5-8, all students must use the following scientific processes, with appropriate laboratory safety techniques, to construct their knowledge and understanding in all science content areas:

- Identify questions that can be answered through scientific investigations;
- Design and conduct a scientific investigation;
- Use appropriate mathematics, tools and techniques to gather data and information;
- Analyze and interpret data;
- Develop descriptions, models, explanations and predictions;
- Think critically and logically to connect evidence and explanations;
- Recognize and analyze alternative explanations and predictions; and
- Communicate scientific procedures and explanations.

Theme: Order and Organization

This theme focuses on helping students use scientific inquiry to discover patterns, trends, structures and relationships that may be described by simple principles. These principles are related to the properties or interactions within and between systems.

Ohio's New Learning Standards: English Language Arts College and Career Readiness Anchor Standards Grades K-12

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Speaking and Listening
Comprehension and Collaboration: ● Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. ● Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. ● Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric. **Presentation of Knowledge and Ideas:** ● Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.
Language
Vocabulary Acquisition and Use: ● Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

- **Grade 4:**
  - **Earth and Space Science**
    - *Topic: Earth's Surface*
      - This topic focuses on the variety of processes that shape and reshape Earth's surface.
      - Condensed Content Statements:
        - Earth' surface has specific characteristics and landforms that can be identified.
        - The surface of Earth changes due to weathering.
- **Grade 7:**
  - **Physical Science:**
    - *Topic: Conservation of Mass and Energy*
    - This topic focuses on the empirical evidence for the arrangements of atoms on the Periodic Table of Elements, conservation of mass and energy, transformation and transfer of energy
    - Condensed Content Statements:
      - Energy can be transformed or transferred but is never lost.
      - Energy can be transferred through a variety of ways.

Learning Experience Overview

Essential Question

How can you divert the foam/lava from crashing into the building?

Enduring Understandings

Have students use the engineering design process to create a design that will divert the lava/foam, using the materials given, in the time given, to save the building

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from the flow. How can they most successfully divert or block the lava foam flow to save the building?

Design Challenge Problem/Scenario

Engineering Design Challenge

Mount St. Helens is erupting shortly. Your task is to create a structure that will save the surrounding building before the lava places the civilians in danger. You have around 15 minutes to complete the task and save the building from the flow.

Prerequisite Knowledge & Skill (as connected to academic content standards)

- An understanding of volcanos and eruptions.
- Understanding of how materials may work better than others.

Activity Timeframe and Overview *(53 minutes)*

Activity	Time allotment	Description
Ex - pretest	5 minutes	Hand out and administer the pretest provided in the kit
Introductory power point	2 minutes	Go through the introductory power point that describes what engineers do
Introduce scenario and watch video	3 minutes	Describe scenario, watch video in PowerPoint
Share design goals and introduce materials.	2 minutes	Share design goals- build a design that protects the building, must be built in time given, can only use materials provided and within limits given. You will have: Wooden craft sticks, masking tape, duct tape, straws, foam plate, cardboard, foam cups, Crayola modeling clay, foil, Lego blocks, toothpicks.

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Share how design will be tested.	2 minutes	Students will build their design. Three groups will then bring their designs to the testing tin where the houses are set up. They will then watch as the facilitator mixes the ingredients for the lava foam (on lid of kit as well as following this.) The facilitator will mix the reaction and advise students to step back and observe. The designs will be evaluated based on the level of protection their design provided from the lava flow. A design is successful if it protects the house entirely from the lava. Designs can also be evaluated based on the relation of which design was most successful of the three being tested at the same time. The groups will continue to be tested in groups if three until all groups have tested their design. Place the houses in the tin spread apart in marked three areas. Have groups place their design where they determine would be the best spot to implement their design.

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Share engineering design process	3 minutes	Don't let the students get their materials until they have their designs, adjust times and process as needed
		Explain how groups will work.
		*At least groups of two - no one works alone.
		*Groups must work together in creating ideas and design.
		Create and improve
		• May need multiple test sites set up depending on group size
		• Final test
		  • May need multiple test sites set up depending on group size
		  • Have each group showcase how their design works
		  • Test three groups at a time
		Probing questions for discussion –
		• Does the placement of the design make a difference on how the design works?

Brainstorming	3 minutes	Each person in each group must come up with one or two ideas. Group must discuss each person's ideas Decide on idea using criteria: what is most important to them what is least important to them what are they restricted by
Creating the idea	2 minutes	Draw and outline the idea get idea checked to move forward

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Gathering Materials	1 minute	Collect materials put together by facilitator.
Create your design	15 minutes	test your design
Final Test of your design	10 minutes	observe your final product write what went well what could/would you change? if your product work how could you make it better? how did it work compared to other groups?
Concluding presentation	5 minutes	Compare to engineering presentation PowerPoint Relate their process to engineering process Show how they did what engineers do Tell them they had fun and they were all good at it What types of engineering this topic relates to?

Material List

Material	Quantity per Team	✓	Quantity per Kit	✓
Wooden Craft Sticks	4		50	
Masking Tape	1 foot		5 yards	
Straws	8		100 straws	
Foam Plate	1		15	
Cardboard	1		15	
Crayola Modeling Clay	1/8 stick		2 sticks	
Foil	3 inches		1 roll	
Lego Blocks	5		60	
Toothpicks	10		100	
Duct Tape	4 inches		1 roll	

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Foam Cups	½ cup		10	
Clean Plastic Soda Bottle	~		1	
20-Volume Hydrogen Peroxide Liquid (%3)	~		½ cup	
Dry Yeast	~		1 packet (1 tablespoon)	
Warm Water	~		4-5 tablespoons	
Liquid Dish Soap	~		1 tablespoon	
Red Food Coloring	~		1 bottle	
Small Cup (reusable)	~		1	
Waterproof Plastic Structures (Be Creative)	~		4	
Aluminum Roasting/Baking Pan	~		1	
Measuring Cup	~		1 (1/2 cup)	
Measuring Spoon	~		1 (1 tablespoon)	
Mixing Spoon (small)	~		1	
Warm Water	~		1 small bottle	
Sponge (for cleanup)	~		1	
Small Funnel	~		1	
Safety Goggles for Mixing Foam	~		1	
Memory Stick *(With power point and handouts)*	~		1	
Pre-Activity Survey	~		25 copies	
Post-Activity Survey	~		25 copies	
Post-it Notes *(For individual brainstorming)*	1 sheets		25 sheets	
Paper *(For team design sketch)*	1 sheet		15 sheets	

Lava Foam Recipe and Instructions

Foam materials (cost $7.50):

- 1 clean 16 ounce plastic soda bottle -- $1.00
- 1/2 cup of 20-volume hydrogen peroxide liquid (%3) -- $1.00
- 1 Tablespoon (one packet) of dry yeast $1.50 (for 3 packets)
- 4-5 Tablespoons of warm water --$0
- 1 Tablespoon of liquid dish washing soap -- $ 1.00

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● Food coloring -- $2.00
● Small cup -- reusable -- $1.00

Instructions for Foam Paste:

1. Hydrogen peroxide can irritate skin and eyes, so put on those safety goggles and ask an adult to carefully pour the hydrogen peroxide into the bottle.
2. Add 8 drops of your favorite food coloring into the bottle.
3. Add about 1 tablespoon of liquid dish soap into the bottle and swish the bottle around a bit to mix it.
4. In a separate small cup, combine the warm water and the yeast together and mix for about 30 seconds.
5. Now the adventure starts! Pour the yeast water mixture into the bottle (a funnel helps here) and watch the foaminess begin!

Explanation for the foam reaction:
Foam is awesome! The foam you made is special because each tiny foam bubble is filled with oxygen. The yeast acted as a catalyst (a helper) to remove the oxygen from the hydrogen peroxide. Since it did this very fast, it created lots and lots of bubbles. Did you notice the bottle got warm? Your experiment created a reaction called an Exothermic Reaction - that means it not only created foam, it created heat! The foam produced is just water, soap, and oxygen so you can clean it up with a sponge and pour any extra liquid left in the bottle down the drain. This experiment is sometimes called "Elephant's Toothpaste" because it looks like toothpaste coming out of a tube, but don't get the foam in your mouth!

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Testing Materials (cost $8.00):
● 4 waterproof plastic structures (be creative- house figurines, pieces of styrofoam) -- $5.00
● 1 metal baking pan to contain mess -- $3.00

Instruction

Instructional Sequence

Set up testing area with the pan and have materials for toothpaste ready and organized. Begin PowerPoint. Share what engineers do. Explain the scenario and watch the video. Share how the video and scenario fit. Give students their design goals. Share the materials and constraints given. Share the engineering design process and allow the students to begin brainstorming. Once their idea has been approved they can begin building using their design goals. Students will builds their design. Three groups will then bring their designs to the testing tin where the houses are set up. They will then watch as the facilitator mixes the ingredients for the lava foam (on lid of kit as well as

following this.) The facilitator will mix the reaction and advise students to step back and observe. The designs will be evaluated based on the level of protection their design provided from the lava flow. A design is successful if it protects the house entirely from the lava. Designs can also be evaluated based on the relation of which design was most successful of the three being tested at the same time. The groups will continue to be tested in groups if three until all groups have tested their design.
Place the houses in the tin spread apart in marked three areas about six inches apart . Have groups place their design where they determine would be the best spot to implement their design. End presentation sharing probing discussion questions.

STEM Career Connections

STEM Career Connection

- **Chemical Engineering:** the branch of engineering concerned with the design and operation of industrial chemical plants.
- **Civil Engineering:** the design, construction, and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams, and buildings.

Chemical applies to the foam explosion.
Civil applies to the building of a design to save the building.

Assessments

- Pre-Activity Survey
- Post-Activity Survey

References

Ohio's new learning standards. *Ohio department of education*. 08 Aug 2014. Retrieved from: http://education.ohio.gov/Topics/Ohio-s-New-Learning-Standards/Ohios-New-Learning-Standards.

Appendices

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