TURNING IDEAS INTO REALITY:
ENGINEERING A BETTER WORLD

The Three Little Pigs

Targeted Grades
5, 6, 7, 8

STEM Career Connections
Architecture and Construction
Civil Engineering
Architecture & 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.

University of Dayton Diversity Engineering Program

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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 grades 5-8 appropriate skills expected of students:

- 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: Physical Science Grades 5-8

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Grade 5: Light, Sound and Motion

Content Statement:

The amount of change in movement of an object is based on the mass* of the object and the amount of force exerted.

Movement can be measured by speed. The speed of an object is calculated by determining the distance (d) traveled in a period of time (t).

Earth pulls down on all objects with a gravitational force. Weight is a measure of the gravitational force between an object and the Earth.

Any change in speed or direction of an object requires a force and is affected by the mass* of the object and the amount of force applied.

Content Elaboration:

The motion of an object can change by speeding up, slowing down or changing direction. Forces cause changes in motion. If a force is applied in the same direction of an object's motion, the speed will increase. If a force is applied in the opposite direction of an object's motion, the speed will decrease. Generally, the greater the force acting on an object, the greater the change in motion. Generally, the more mass* an object has, the less influence a given force will have on its motion. If no forces act on an object, the object does not change its motion and moves at constant speed in a given direction. If an object is not moving and no force acts on it, the object will remain at rest.

Movement is measured by speed (how fast or slow the movement is). Speed is measured by time and distance traveled (how long it took the object to go a specific distance). Speed is calculated by dividing distance by time. Speed must be investigated through testing and experimentation. Real-world settings are recommended for the investigations when possible.

An object that moves with constant speed travels the same distance in each successive unit of time. In the same amount of time, a faster object moves a greater distance than a slower object. When an object is speeding up, the distance it travels increases with each successive unit of time. When an object is slowing down, the distance it travels decreases with each successive unit of time.

**While mass is the scientifically correct term to use in this context, the NAEP 2009 Science Framework (page 27) recommends using the more familiar term "weight" in the elementary grades with the distinction between mass and weight being introduced at the middle school level.*

Grade 6: Matter and Motion

Content Statement:

There are two categories of energy: kinetic and potential.

Objects and substances in motion have kinetic energy.

Objects and substances can have energy as a result of their position (potential energy).

Content Elaboration:

There are many forms of energy, but all can be put into two categories: kinetic and potential. Kinetic energy is associated with the motion of an object. The kinetic energy of an object changes when its speed changes. Potential energy is the energy of position between two interacting objects. Gravitational potential energy is associated with the height of an object above a reference position. The gravitational potential energy of an object changes as its height above the reference changes.

Note: Using the word "stored" to define potential energy is misleading. The word "stored" implies that the energy is kept by the object and not given away to another object. Therefore, kinetic energy also can be classified as "stored" energy. A rocket moving at constant speed through empty space has kinetic energy and is not transferring any of this energy to another object.

Grade 7: Conservation of Mass and Energy

Content Statement:

Energy can be transferred through a variety of ways.

Mechanical energy can be transferred when objects push or pull on each other over a distance.

Content Elaboration:

Mechanical energy is transferred when a force acts between objects that move one of the objects some distance with or against the force. The amount of energy transferred increases as the strength of the force and/or the distance covered by object increases. This energy transfer (work) stops when the objects no longer exert forces on each other.

Grade 8: Conservation of Mass and Energy
Content Statement: **Energy can be transferred through a variety of ways.** Mechanical energy can be transferred when objects push or pull on each other over a distance. **Content Elaboration:** Mechanical energy is transferred when a force acts between objects that move one of the objects some distance with or against the force. The amount of energy transferred increases as the strength of the force and/or the distance covered by object increases. This energy transfer (work) stops when the objects no longer exert forces on each other.

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

Learning Experience Overview

Essential Question

What makes a house made out of popsicle sticks, straws, or cards strong enough to withstand the destructive forces of wind, rain, and hail?

Enduring Understandings

- Using the engineering design process when approaching problems results in unique solutions.
- A forces ability to move an object is dependent on the object's mass and stability.

Design Challenge Problem/Scenario

You have finally earned enough money to build the house of your dreams near a Florida beach. You want to make sure your structure is built to withstand the destructive force of a big bad wolf's huffing and puffing to blow you house down! WAIT…where you are building, hurricanes occur more frequently than the huffing and puffing of a big bad wolf. In that case, a better idea is to make sure your structure is built to withstand the destructive forces of a hurricane's wind, rain, and hail.

Engineering Design Challenge

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Your team's challenge is to build three different houses, each constructed with a material similar to what The Three Little Pigs used.

Straw, stick, and brick houses, built by The Three Little Pigs, were tested for their ability to withstand the destructive force of The Big Bad Wolf's huffing and puffing. Your drinking straw, popsicle stick, and card houses will be tested for their ability to withstand the destructive forces of a hurricane's wind, rain, and hail.

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

- **Concepts Related to Energy in Grades PreK-2:** A variety of sounds and motions are experienced. The sun is the principle source of energy.
- **Concepts Related to Energy in Grade 3-4:** Objects with energy have the ability to cause change. Heat, electrical energy, light, sound and magnetic energy are forms of energy.

Activity Timeframe and Overview *(58 minutes)*

Activity	Time	Overview
Introduction	*2 minutes*	Introduce Yourself Provide Brief Activity Overview to Foster Excitement
Pre-Assessment	*3 minutes*	Administer Kit's Pre-Activity Survey
Design Challenge Introduction	*10 minutes*	Begin PowerPoint Presentation: ● Guide Discussion ● Present the Engineering Design Challenge ● Explain the Engineering Design Process
Individual Brainstorm	*5 minutes*	Team Members Individually: ● Write 1-2 Solution Ideas
Prototype Design and Construction	*20 minutes*	Teams Collaboratively: ● Discuss Individual Ideas ● Choose and Sketch Final Idea for Approval ● Gather Materials and Construct Team Prototype
Testing	*10 minutes*	Perform and Observe Prototype Testing
Conclusion	*5 minutes*	Relate to Engineering; They Did What Engineers Do Connect to Types of Engineering
Post-Assessment	*3 minutes*	Administer Kit's Post-Activity Survey

Material List

Material	Quantity per Team	✓	Quantity per Kit	✓

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Combine following supplies in a baggie			10 baggies	
Play dough	1 small tub or stick		10 small tubs or sticks	
Painters Tape	1 yard		2 rolls	
Glue Sticks or Bottles	1		10	
Popsicle Sticks	16		160	
Deck of Cards	6 cards		60 cards	
Straws	20		200	
Waxed Paper	1 square foot (approx.)		1 roll	
Fan or Blow Dryer *(For testing)*	~		1	
Cups for Water and Beans *(For testing)*	~		2	
Tub or Bin *(To catch water and beans during testing)*	~		1	
Container or Jug *(for holding water used in testing)*				
Beans *(For testing)*	~		1 bag	
Memory Stick *(With power point and handouts)*	~		1	
Pre-Activity Survey	~		35 copies	
Post-Activity Survey	~		35 copies	
Cardstock	1 sheet		10 sheets	
Paper *(For individual brainstorming)*	1 sheet		25 sheets paper	
Paper *(For team design sketch)*	1 sheet		10 sheets	

Instruction

Instructional Sequence

Note: The activity's PowerPoint presentation guides instruction and visually presents information to students. Therefore, the instructions include corresponding slide numbers.

1. Slide 1: As the pre-activity survey is distributed to students, introduce yourself and provide enough of an activity overview to gain students excitement.
2. Allow time for students to individually complete their pre-activity survey.
3. Divide group into teams of 3 students each (3 or 4 student teams will also work).

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4. Slides 2 and 3: Discuss engineering and what engineers do.
5. Present the engineering design problem and challenge, following the presentation:
   - Slide 4: Explain that they will be taking on the role of civil engineers.
   - Slide 5: Present the real-world engineering design problem (scenario).
   - Slide 6: Introduce the Engineering Design Challenge.
   - Slide 7: Discuss Engineering Design Goals.
   - Slide 8: Introduce resources (materials) available to each team.
   - Slide 9: Explain prototype-testing procedures.
6. Slide 10: Introduce the Engineering Design Process. Explain that engineers use it as a tool to help them more effectively solve problems.
7. Slide 11: Explain how teams will use the engineering design process as they complete the challenge:

   Imagine *(10 min.)*
   - INDIVIDUALLY: observe available materials, and brainstorm and write design ideas *(5 min.)*
   - TEAM: share individual ideas *(5 min.)*

   Plan *(5 min.)*
   - Choose and sketch a team design plan

   Create *(10 min.)*
   - Gather materials
   - Construct your team design plan

   Improve and Test *(10 min.)*
   - Teams decide on and make any last minute improvements before testing
   - Each team tests their prototype while other teams observe.
8. Slide 12: Facilitate a whole group reflection on final prototype design and testing results by asking questions such as the following.
   - What do you like best about your design?
   - What do you like least about your design?
   - What aspects of other team designs stood out to you, and/or gave you ideas for improving your own team's design?
   - What modifications would you make if we had time to complete the design challenge again?
   - How did the materials affect the ability for the houses to withstand the forces applied to them?
9. Slide 13: Conclude by discussing the following questions as post-activity surveys are distributed.
   - What ideas do you have for engineering a better world?
   - How can you turn ideas into reality?
10. Slide 14: Allow time for students to complete their post-activity survey.

STEM Career Connections

STEM Career Connection

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Civil Engineering: This activity promotes civil engineering because it has to do with the fundamentals of building a house. Building any structure is a large part of civil engineering. They also can focus on sustainability and water systems.

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.

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