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SSC
Secondary STEM Council

Annual Global Design Challenge for Secondary STEM Students

Deadline: December 15, 2024

Graduation Trouble: Coastal Defense System for Historical Town Pavilion

Defend Our Pavilion from Rising Tides!

In 2008, the U.S. National Academy of Engineering (NAE) identified 14 Grand Challenges for Engineering in the 21st Century. The Grand Challenges were designed to cause students and educators to think about solutions to the big challenges affecting us all. ITEEA's Secondary STEM Council is again sponsoring the Global Design Challenge (GDC) for Secondary STEM to provide students with a chance to solve a real problem and show the world that everyone can help find solutions to these global challenges. We encourage you to showcase to the world that students are capable of tackling big problems with creativity and ingenuity.

Scenario:
High school graduation is approaching, and the historical town pavilion, a cherished landmark and gathering place, which is the designated venue for the ceremony is threatened by encroaching water due to erosion, storm surges, and rising water levels. Access to the path leading to the pavilion is at risk and the community needs your help.

Challenge:
Design and implement a coastal defense system to mitigate these threats and ensure graduation can proceed as planned. Working with a small group, your job is to engineer a solution to manage the water to ensure safe access to the historical town pavilion on the shoreline. Using materials provided, design and build a model of a solution that will effectively keep the pathway leading from the shoreline to the pavilion accessible.

Limitations:
1. Create a solution that will effectively keep the walkable pathway leading from the shoreline to your pavilion accessible.
2. The solution should divert or drain the water, or otherwise ensure a safe pathway to the pavilion.
3. This solution should be stable and able to withstand the water flow without collapsing.
4. Test the solution in your own classroom and determine its effectiveness.

Test:
Demonstrate how your solution will work. Set up a test that simulates the rising water on the pathway from the shore to your pavilion (simulated waves, or storm surges, or flooding, etc.). It is up to you to test and demonstrate effectiveness, stability, creativity, and resourcefulness. Throughout the testing process, record your observations, measurements, and any adjustments made to your design.

Effectiveness: Does your solution effectively divert or drain the water away from the pathway to the pavilion, or otherwise ensure a safe pathway to the pavilion?
Stability: Is your design stable and able to withstand the water flow without collapsing?
Creativity: Have you used innovative and creative ideas in your design?
Resourcefulness: Have you made efficient use of the materials you chose?
Presentation: Can you explain your design and its function clearly to others?

Examples of Possible Ways to Test

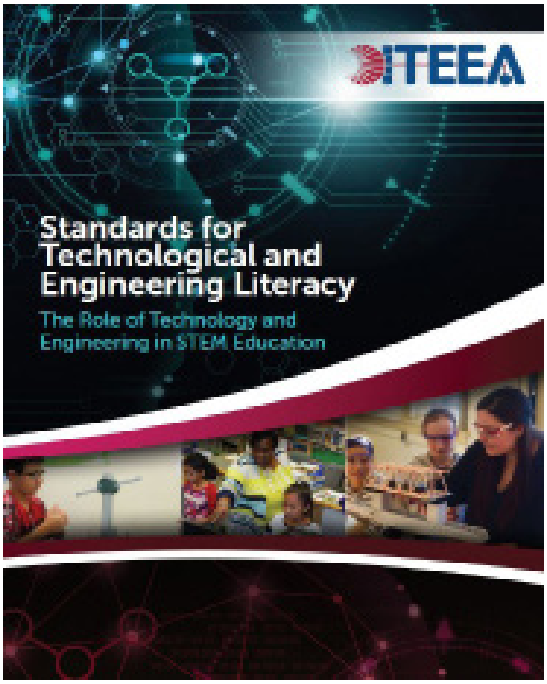
- In a terrarium, a tub, or a kiddie play pool, you might simulate wave action by gently pouring water from a container onto a small section of sand or soil representing the shoreline. Then you could measure the distance the water travels inland on the "pathway" before reaching the pavilion. Next, with your solution in place, gently pour the water again and measure the distance the water travels.
- Using a 13x9 baking pan or small tub, you might simulate wave action by filling the pan halfway with water and using a plastic bottle to create waves by gently pressing and moving the bottle back and forth. Measure the distance the water travels before and after your solution is in place.
- Use a spray bottle to simulate a storm surge, observing how your design holds up under increased water flow and pressure.
- Build a simple wave tank creating paddle movement to simulate wave action. Use a clipboard or cut a piece of plywood or foam board to fit the width of the tank. This will serve as the wave paddle. Attach a handle to the paddle, allowing it to be moved up and down to generate waves manually. Fill the tank with water to the desired level. Use the paddle to create waves by moving it up and down at a consistent pace. Alternatively, use the electric pump or motor to automate wave generation. https://youtu.be/Xrs-Wbh-qCo?feature=shared

Content Information for Teachers:
You may want to equip the students with essential content knowledge, ensuring they are well-prepared for problem-solving:

Erosion: The process of breaking down of land or structures by natural forces such as water or wind.
Shoreline: The boundary between land and water, where the land meets the sea, a lake, or river.
Breakwater: A structure built offshore along a shoreline to protect coastal areas from the force of waves and reduce erosion.
Storm Surge: The ocean water rises higher than normal because of a big storm. It can cause the water to come up onto the land and make everything very wet and sometimes cause flooding.
Sediment Transport: The movement of solid particles (sediment) due to water flow, which can cause erosion and deposition.
Living Shorelines: Coastal management practices that use natural elements like plants, sand, and rock to stabilize shorelines.
Sustainability: Designing solutions that meet current needs without compromising the ability of future generations to meet theirs.
Environmental Impact: The effect of a project or action on the natural environment.
Other concepts for class discussion: riprap, revetments, living shoreline, geotextile bags, gabions. etc.

Incorporating Literature: *The Wave: In Pursuit of the Rogues, Freaks, and Giants of the Ocean* by Susan Casey, *Life as We Knew It* by Susan Beth Pfeffer, Isaac's *Storm: A Man, a Time, and the Deadliest Hurricane in History* by Erik Larson, and *Engineering in Our Everyday Lives* by Erin E. Brummett

STEL Standards



Standard 1: Nature and Characteristics of Technology and Engineering

Grades 6-8

J. Develop innovative products and systems that solve problems and extend capabilities based on collective needs and wants
L. Explain how technology and engineering are closely linked to creativity, which can result in both intended and unintended innovations.
M. Apply creative problem-solving strategies to the improvement of existing devices or processes or the development of new approaches

Grades 9-12

N. Explain how the world around them guides technological development and engineering design
P. Analyze the rate of technological development and predict future diffusion and adoption of new technologies.
Q. Conduct research to inform intentional inventions and innovations that address specific needs and wants.
R. Develop a plan that incorporates knowledge from science, mathematics, and other disciplines to design or improve a technological product or system.

Standard 7: Design in Technology and Engineering Education

Grades 6-8

P. Illustrate the benefits and opportunities associated with different approaches to design.
Q. Apply the technology and engineering design process.
R. Refine design solutions to address criteria and constraints.
S. Create solutions to problems by identifying and applying human factors in design.
T. Assess design quality based upon established principles and elements of design.
U. Evaluate the strengths and weaknesses of different design solutions.
V. Improve essential skills necessary to successfully design.

Grades 9-12

W. Determine the best approach by evaluating the purpose of the design.
X. Document trade-offs in the technology and engineering design process to produce the optimal design.
Y. Optimize a design by addressing desired qualities within criteria and constraints.
Z. Apply principles of human-centered design.

Standard 8: Applying, Maintaining, and Assessing Technological Products and Systems

Grades 6-8

H. Research information from various sources to use and maintain technological products or systems.
I. Use tools, materials, and machines to safely diagnose, adjust, and repair systems.

Grades 9-12

N. Use various approaches to communicate processes and procedures for using, maintaining, and assessing technological products and systems.
P. Apply appropriate methods to diagnose, adjust, and repair systems to ensure precise, safe, and proper functionality.

Go to https://tinyurl.com/ITEEAGDCSSC2024
For questions about the Global Design Challenge contact
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