Engineering Design Challenges in the STEM Classroom

Making STEM a Meaningful Experience
Group Expectations

- Participate
- Professional
- Positive
- Prompt

- Communication
- Collaboration
- Flexibility
- Persistence
- Presentation
- Innovation
- Technology
Trainer:
Veronica Burnett
STEMscopes

Comprehensive K-12 Digital Curriculum
Created by Teachers for Teachers
Designed for your specific standards
The 5 E Instructional Model

- The staple of quality science instruction
- Intervention and acceleration help both struggling and advanced learners to be successful
Engineering Design Challenge
Making STEM a Meaningful 3D Experience
Are you STEM Ready?

Self Assessment

Novice
- Not aware
- no understanding of the practice
- not using practice at all.

Gaining Skill
- Basic understanding of the practice
- not using the practice frequently.

Proficient
- Understanding of the practice and
- using the practice regularly as needed.
What is STEM?

- Write a definition for each content area in STEM.
Defining STEM?

- **Science** - Science seeks to explain the natural world through observations and investigations.

- **Math** - Math is a language used to solve problems.

- **Technology** - Technology is procedure, system, idea or tool that improves and extends our ability.

- **Engineering** - is the designing of technology used to solve problems.
STEM is Engaging in The Practices of Scientists and Engineers:

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Engaging in The Practices of Scientists and Engineers
Practices of Scientists and Engineers to Design an *Earthquake Proof Tower*

**Challenge:** Create a tower that can survive the waves created on the Earth’s surface during an earthquake.

**Criteria:**
- Brainstorm with your team of 4-5, and have a drawn plan
- Remain standing for 10 seconds, on a moving table.
- Be of a height of least 3 feet or more

**Constraints:**
- 1 file folder
- 60 cm masking tape
- 5 minutes to plan
- 15 minutes to build
Reflection on Tower Building Work

Rate your group on the following:

1. To what level did your members work as a team?
2. To what level did your tower meet the criteria?
3. To what degree was your tower able to withstand the forces exerted by the earthquake?
   - What was your innovation?
4. To what extent were your team members able to explain the transfer of energy from the table to the tower?
5. What would you do differently next time?
Engineering Design Process

• Using the package of cards given to you, divide them evenly among your group

• Use consensus in a Round Robin fashion to place them in the order you did each in the construction of the tower.
What is Consensus?

You have consensus if you can state the following:

1. I have been heard and understood.
2. I have heard and understand.
3. I can live with it.
4. I can (and will) publicly support it.

-- from Capturing Kids Hearts
Engineering Design Process

• Using the package of cards given to you, divide them evenly among your group

• Use consensus in a Round Robin fashion to place them in the order

• Be creative and do not think of it as a linear process

You will have 10 minutes.
Protocol for Discourse

One person distributes the cards evenly to the group by dealing them out. Do not reveal your cards until your turn.

Person #1 places one card in the center of the table

Person #2 places one card before or after the original card.
- Make a **claim**: “This card should go before/after ____ because…”
- State the **evidence** to support the claim.
- **Justify** it’s placement. Answer clarifying questions.
- Team members provide additional evidence to support the claim or refute the claim with other evidence.

Proceed around the table, placing one card per person at a time.
- Repeat the process of Claim, Evidence, Reasoning

Continue for all 15 cards, you will have 10 minutes.
Gallery Walk – One Stays the Rest Stray

- A person from your group to be chosen to be the spokesperson. 
  *Rehearse what they will say to reflect the groups’ thinking*

- Divide up your group to each go to a different table. 
  *Each person goes to only one other table.*

- Listen to the presenter and ask clarifying question.

- Return to your home group and report out your new findings. 
  *Discuss with your group if you want to change the order of your EDP.*
Engineering Design Process

Engineering Design in the K-12 Framework and the NGSS

Rice Engineering Design Kitchen

Engineering is Elementary, Science Museum of Boston
Imagine, Brainstorm, Research
Define the Problem, Criteria, & Constraints
Plan a Prototype
Build, Test, Redesign
Present Solution and Utilize

Engineering Design Process
Redefining Failure as the “Next Step” in Building Persistence

James Dyson
Engaging in 21st Century Skills

- Collaboration
- Communication
- Presentation
- Creativity-Innovation
- Integration of Technology
- Persistence
- Critical Thinking
Reflection Questions

• When thinking about incorporating Engineering Design into your science classroom what do you think the purpose of science is in the EDP?

• Why is it brought into your science standards?

• Share with three others in the room

  HandUp, StandUp, PairUp process.
Final Thoughts

“We have not succeeded in answering all of your questions. The answers we have found only serve to raise a whole set of new questions. In some ways, we feel we are as confused as ever, but we believe we are confused on a higher level and about much more important things!"

Thank you!
Dive-In Engineering

- Partnership with NY Hall of Science
- Maker Movement
- Grades 3-8

- Agnostic to STEMscopes
- Available Fall 2017
Get STEM Certified

- Individual Teachers
- School-level
- District-wide

getstemcertified.com
DIVE in Engineering

https://www.acceleratelearning.com/dive-in/

CallAMY CANALES
(915) 309-0539
to learn more about the
Online Resources available through STEMscopes.
Thank you for your participation and engagement!
Engineering Design Challenges

Dropbox Folder Link for:
PDF of the Presentation, Handout and EDP Cards

Call AMY CANALES at (915) 309-0539
to learn more about the Online Resources available through STEMscopes.
Visit our Booth to receive a 30-Day FREE Preview of our Online Curriculum!!!
Using the Practices of STEM & The NGSS Standards

The Engineering Design Process
Students who demonstrate understanding can:

**4-PS4-1.** Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move. [Clarification Statement: Examples of models could include diagrams, analogies, and physical models using wire to illustrate wavelength and amplitude of waves.] [Assessment Boundary: Assessment does not include interference effects, electromagnetic waves, non-periodic waves, or quantitative models of amplitude and wavelength.]

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**Science and Engineering Practices**

**Developing and Using Models**

Modeling in 3–5 builds on K–2 experiences and progresses to building and revising simple models and using models to represent events and design solutions.

- Develop a model using an analogy, example, or abstract representation to describe a scientific principle.

**Connections to Nature of Science**

**Scientific Knowledge is Based on Empirical Evidence**

- Science findings are based on recognizing patterns.

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**Disciplinary Core Ideas**

**PS4.A: Wave Properties**

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: This grade band endpoint was moved from K–2.)

- Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks).

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**Crosscutting Concepts**

**Patterns**

- Similarities and differences in patterns can be used to sort, classify, and analyze simple rates of change for natural phenomena.

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**Connections to other DCIs in fourth grade:**

4.PS3.A; 4.PS3.B

**Articulation of DCIs across grade-levels:**

MS.PS4.A

**Common Core State Standards Connections:**

- **ELA/Literacy - SL.4.5** Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. (4-PS4-1)
- **Mathematics - MP.4** Model with mathematics. (4-PS4-1)
- **4.G.A.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures. (4-PS4-1)

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Problem:
When an earthquake occurs, waves travel through the earth. These waves cause the crust to move as well as the buildings that are on top of the crust. These buildings are often damaged, some are even destroyed.
Wavelength and Amplitude

Located In Your Handout

Waves in the Earth

Expert Roles

There are four expert roles, and your group needs to have at least one member of each role. The following roles are included:

- Design Team Expert
  - Architectural Engineer
  - Material Engineer
  - Mechanical Engineer

- Design Plan Notes:

Rubric

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>Expert (4)</th>
<th>Competent (3)</th>
<th>Beginner (2)</th>
<th>Novice (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>The product is able to maintain its shape after being lightly shaken for 10 seconds.</td>
<td>The product is able to maintain most of its shape after being lightly shaken for 10 seconds.</td>
<td>The product maintains only some of its shape after being lightly shaken for 10 seconds.</td>
<td>The product is not able to maintain its shape after being lightly shaken for 10 seconds.</td>
</tr>
<tr>
<td>Criteria Expectations</td>
<td>All the criteria of the blueprint were followed.</td>
<td>All but one of the criteria were followed.</td>
<td>Only one aspect of the criteria was followed.</td>
<td>None of the criteria was followed.</td>
</tr>
<tr>
<td>Presentation</td>
<td>Explanations by all group members indicate a clear and accurate understanding of the principles underlying the design.</td>
<td>Explanations by all group members indicate a relatively accurate understanding of the principles underlying the design.</td>
<td>Explanations by most group members indicate a relatively accurate understanding of the principles underlying the design.</td>
<td>Explanations by several members of the group do not illustrate much understanding of the principles underlying the design.</td>
</tr>
<tr>
<td>Teamwork</td>
<td>All members of the group worked together. Communication was respectful, and everyone was able to listen and be heard.</td>
<td>The members of the group worked together most of the time. There was minor discord, but it was resolved with respect.</td>
<td>Members of the group struggled to work together. Some members could work together, but as a whole, they could not work as a team.</td>
<td>There was no teamwork. Some people were completely left out of the group, and there were unresolved arguments.</td>
</tr>
</tbody>
</table>

Accelerate Learning
Top 10 Skills Important in the Workforce

**2015**
1. Complex Problem Solving
2. Coordinating with Others
3. People Management
4. Critical Thinking
5. Negotiation
6. Quality Control
7. Service Orientation
8. Judgement and Decision Making
9. Active Listening
10. Creativity

**2020**
1. Complex Problem Solving
2. Critical Thinking
3. Creativity
4. People Management
5. Coordinating with Others
6. Emotional Intelligence
7. Judgement and Decision Making
8. Service Orientation
9. Negotiation
10. Cognitive Flexibility

(Source: Future of Jobs Report, World Economic Forum)