Design Thinking and Engineering for Young Students

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Bullis Charter School

• K-8 Public Charter School
• 720 Students

Our Mission: Bullis Charter School offers a collaborative, experiential learning environment that emphasizes individual student achievement. As a model of educational innovation, BCS inspires children, faculty and staff to reach beyond themselves to achieve full potential. Using a global perspective to teach about the interconnectedness of communities and their environments, the Bullis Charter School program nurtures mutual respect, civic responsibility, and a life-long love of learning.
Education is Not the Filling of a Bucket but the Lighting of a Fire (Yeats)
Spark Students’ Imagination & Empower Them as Learners

• STEAM Strand
  • Science, Technology, Engineering, Arts, and Mathematics

• Focus on Collaboration, Communication, Critical Thinking, Creativity

• Use of Design Thinking and Project-Based Learning
Design Thinking

- A creative problem-solving process

Includes d thinking dispositions
  - Learn fast
  - Risk taking
  - Growth mindset
  - Creative confidence

Includes d thinking dispositions
  - Show, don’t tell
  - Radical collaboration
  - Bias toward action
  - Culture of prototyping
  - Mindful process
  - Human centered
## Engineering

### K-2. Engineering Design

Students who demonstrate understanding can:

**K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**K-2-ETS1-2.** Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

**K-2-ETS1-3.** Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

The performance expectations above were developed using the following elements from the NRC document *A Framework for K-12 Science Education*.

<table>
<thead>
<tr>
<th>Science and Engineering Practices</th>
<th>Disciplinary Core Ideas</th>
<th>Crosscutting Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Asking Questions and Defining Problems</strong></td>
<td><strong>ETS1.A: Defining and Delimiting Engineering Problems</strong>&lt;br&gt;• A situation that people want to change or create can be approached as a problem to be solved through engineering. (K-2-ETS1-1)&lt;br&gt;• Asking questions, making observations, and gathering information are helpful in thinking about problems. (K-2-ETS1-1)&lt;br&gt;• Before beginning to design a solution, it is important to clearly understand the problem. (K-2-ETS1-1)</td>
<td><strong>Structure and Function</strong>&lt;br&gt;• The shape and stability of structures of natural and designed objects are related to their function(s). (K-2-ETS1-2)</td>
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<tr>
<td><strong>Developing and Using Models</strong></td>
<td><strong>ETS1.B: Developing Possible Solutions</strong>&lt;br&gt;• Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem’s solutions to others. (K-2-ETS1-2)</td>
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<tr>
<td><strong>Analyzing and Interpreting Data</strong></td>
<td><strong>ETS1.C: Optimizing the Design Solution</strong>&lt;br&gt;• Because there is always more than one possible solution to a problem, it is useful to compare and test designs. (K-2-ETS1-3)</td>
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**BULLIS charter school**
Happy the Horse Activity
Empathy: What does Happy like?

- Carrots
- Shade
- To be brushed
- Water
- Hay
- Jumping
- People
- Dogs
Empathy: What doesn’t Happy like?

• Mud

• Wind

• Flies

• Tumble Weed
<table>
<thead>
<tr>
<th>Things that Happy likes</th>
<th>Things that Happy doesn’t like</th>
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<tr>
<td>Carrots</td>
<td>Toys</td>
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<tr>
<td>Shade</td>
<td>People</td>
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<td>Flies</td>
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<td></td>
<td>Mud</td>
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<tr>
<td></td>
<td>Dirty Water</td>
</tr>
<tr>
<td></td>
<td>Tumble Weed</td>
</tr>
</tbody>
</table>
Ideate

What does Happy need? Draw at least three of your ideas.
Chose one idea
Draw a circle around it.
Prototype - use up 10 LEGOos to build your idea
Test
Share your idea with a partner.
Give one I like statement
Describe your gift for happy.

Use the LEGOs to build your gift.
Engineering
Keep Happy Safe
Build a Wall to Keep Happy Safe
Happy has been leaving his yard and crossing the street to eat his neighbor’s flowers. But, it is dangerous to cross the road and the flowers make him sick. Also, the neighbor likes his flowers and doesn’t want Happy to eat them.
Limiting Factors - Height

- A LEGO brick is 1 centimeter high
- Happy likes to look out on the street
- Happy can jump as high as 3 centimeters
- Happy can’t see over anything more than 4 centimeters tall

The wall should be __________ centimeters high.
Limiting Factors

- The gap between the house and fence is 15 centimeters.
- Happy can fit through a 2 centimeter or larger gap.

The wall should be at least __________ centimeters long.
Limiting Factors

- Happy likes to push against things with his head and knock them over.

The wall must pass the __________________________
_______________________________ test.


Limiting Factors Materials

- All bricks (big, small and medium size) cost one dollar ($1) each
- Happy’s family has budgeted twenty dollars ($20) to purchase the bricks

The wall can contain no more than ___________ bricks
What is something that you wonder about?
Advice

Can use any Lego & Duplio bricks

Where to get: families donate old legos, Craig’s List

Choice/Extend:
Students can work with a partner
Teachers can create models to show as examples

Extensions to 6th grade

Meets NGSS and Common Core Standards
Literature Connections: Engineering & Inventing

• *Rosie Revere, Engineer* (Andrea Beaty)
• *Marvelous Mattie: How Margaret E. Knight Became an Inventor* (Emily Arnold McCully)
• *Violet the Pilot* (by Steve Breen)
• *Papa's Mechanical Fish* (Candace Fleming)
• *Awesome Dawson* (Chris Gall)
• *If I Built a Car* (Chris Van Dusen)
• *Galimoto* (Karen Lynn Williams)
• *George Crum and the Saratoga Chip* (Gaylia Taylor)
• *The Most Magnificent Thing* (Ashley Spires)
• *Oh No! Or How My Science Project Destroyed the World* (Mac Barnett)
Resources

Next Generation Science Standards
http://www.nextgenscience.org/next-generation-science-standards
K-2 Engineering and Design Standards

Design Thinking
d school (Stanford): http://d.school.stanford.edu/use-our-methods/
How to Apply Design Thinking in Class, Step by Step (Mindshift)
PBS Kids Design Squad
HFLI Elementary School’s K-5 Scope and Sequence for Design Challenges
IDEO’s Design Thinking for Educators Toolkit

Engineering and Making
Engineering is Elementary website (includes curriculum, after school activities, and PD)
How to teach Project-Based Engineering to Students
Teaching NGSS Engineering Design Through Media (PBS Learning Media)
Agency by Design website

STEM/STEAM
8 Videos to Get Girls into STEM (Edutopia, 5 minute film festival)
PBL and STEAM Education—a Natural Fit (Andrew Miller, Edutopia)
10 Innovative Ways to Bring STEM to Schools (Mindshift)
Reflection/Feedback

Help us become better presenters by completing our feedback survey-thanks!