We need to give students experiences that help them grow as both independent thinkers and collaborators with others. STEM challenges allows students to explore with materials while also experiencing the interdisciplinary aspects of science, technology, engineering, and math rather than being taught separately in isolation. This interactive process engages students in: sharing ideas, asking questions while working, problem-solving and coming up with creative solutions, etc. The hands-on STEM approach allows for decision-making and finding solutions as students make models/prototypes and test/improve their ideas in a safe environment.

NGSS: Next Generation Science Standards Science and Engineering Practices*
• Asking questions and defining problems • Developing and using models
• Planning and carrying out investigations • Analyzing and interpreting data
• Using mathematics and computational thinking • Constructing explanations and designing solutions • Engaging in argument from evidence
• Obtaining, evaluating, and communicating information

NGSS: Crosscutting Concepts

Common Core Standards
Setting the Stage for Tinkering, Building & Art

Ingredients for STEM Pedagogy
- Exploration - creating with materials, how can we use/change it
- Collaboration - communicating, negotiating, using each other’s ideas
- Imagination - using creativity to solve, create and bring an idea to life
- Project-based learning - making personal connection, hands-on

STEM: What can you do?
- Take small steps: reflect on current teaching
- Adopt an open mindset to increase student engagement
- Provide hands-on projects/materials to enliven content

Adopt & Implement: Next Generation Science Standards
Science & Engineering Practices • Crosscutting Concepts

When planning your learning environment, dedicate an area where students have access to building sets and art materials that encourage open-ended explorations.

<table>
<thead>
<tr>
<th>Building Materials</th>
<th>Art/Craft Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Legos</td>
<td>rubber bands</td>
</tr>
<tr>
<td>Magna Tiles</td>
<td>string</td>
</tr>
<tr>
<td>straws &amp; connectors</td>
<td>scissors</td>
</tr>
<tr>
<td>wood blocks: large &amp; sm.</td>
<td>staplers</td>
</tr>
<tr>
<td>planks: I Can Build! w/</td>
<td>holepunchers</td>
</tr>
<tr>
<td>cards (Lakeshore)</td>
<td>tape, masking, blue</td>
</tr>
<tr>
<td>Jenga</td>
<td>glue</td>
</tr>
<tr>
<td>Keva planks</td>
<td>glue sticks</td>
</tr>
<tr>
<td>Skyscraper Cards (Roylco)</td>
<td>paints, watercolors</td>
</tr>
<tr>
<td>tinker toys</td>
<td>pom moms</td>
</tr>
<tr>
<td>Interlox (square &amp; discs)</td>
<td>yam</td>
</tr>
</tbody>
</table>
Architect: Building with Index Cards

**Literature:** Look at That Building! Scot Ritchie  
*The Shape of the World A Portrait of Frank Lloyd Wright, K. L. Going*

**Goal:** Design with geometric shapes: rectangle, triangle, cylinder

**Materials:** 15-20 index cards 4x6  
masking tape - 1-ft. or 2-ft. lengths, pre-cut cardboard base, 6”x12”

**Warm-up:** Demonstrate folding index cards into shapes

- rectangle
- triangle
- cylinder

---

**Index Card Tower - 4x6 index cards, masking tape, cardboard base: 6”x12”**

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**Literature: Bridges**
Exploration & Hypothesis
After building, one of my students wanted to check if her structure would hold weight. She decided to test her idea with the tape dispenser. **Success!** Her design held the dispenser without collapsing.

Inspiration for Others
As a result, the students nearby started to test how strong/stable their structures with various objects.

Sharing Designs
After building, students shared about the structures they designed and constructed. Most identified the shapes that they used and the height of the structure, if they measured it.

Reflections/
As students shared about their experience, they ....

Math Graphs
- How tall?
- What shapes?
- How many index cards?
- How many tape strips?

Architect: Building with Index Cards
TOWER POWER

GOAL  Design a tower that will hold the weight of a small plush animal.

PROBLEM: The plush animal is too small to see when it is on the ground. People might step on the small animal or kick it because they can’t see it easily.

CRITERIA for SUCCESS
The tower holds the plush animal without collapsing or toppling over. Challenge: Make the tower 12-inches (1-ft) tall. Or as high as you can before it falls.

CONSTRAINT: You may only use index cards. Start with 25 and pick up more as needed.

Engineering Teamwork and Planning

Talk with your partner about ideas.

Think about the different ways you can use the index cards. Remember: You can fold, roll or change the index cards.

Test the strength of the tower as you build.

Are you ready?
Build.
Test.
Improve.

Extensions
Make a graph to record the heights of towers.
Record how many levels tall the towers are.
Talk about the shapes of index cards. Are some shapes stronger?

Gallery Walk
Share towers or take a gallery walk.
Write observations on Post-its to attach on a chart.
Or write directly on a chart.
Building Bridges: Index Cards

Literature: Iggy Peck, Architect, Billy Goats Gruff, Gingerbread Man

GOAL
Build a bridge to meet the criteria of strength and stability.

CRITERIA for SUCCESS
The bridge is strong and stable to support weight*. (pennies or a car)

MATERIALS
- index cards, 4”x6” for small bridge, 5”x8” for large bridge
- tape
- cars
- pennies or metal washers
- work mat: print on card stock

Option page 2: Larger bridge building with straws, paper clips, sticks
- Use 12”x18” poster board or cardboard with blue river strip, approximately 5-6” width along center

Pre-Discussion & Demonstration
- Bridge Vocabulary: span, abutment, beam, arch
- Water template (PDF): Print on card stock weight paper
- Make/show abutment shapes: rectangular prism, triangular prism, cylinder
  Shapes can be used along flat length or upright (taller bridge)

Small Bridge Models
### Option 2: Larger Scale Bridge Construction

**Materials:** 5”x8” index cards, 12”x18” base, sticks (wide), straws, string, paper clips  
**Note:** Bridge span may not be taped to the abutments, placed on top independent

### Bridges Constructed with Planks

### Literature: Bridges

![Image of Iggy Peck, Architect](image1.png)  
![Image of Building Bridges](image2.png)  
![Image of Here to There and Me to You](image3.png)
Hands On  STEM Explorations with Legos

Teacher Prep: PDF Resource
- Print a set of cards on card stock paper.
- Cut apart.
- Option: Punch a hole.
  Attach cards to a binder ring.

Build a boat.
Test to see if can float.

Design a bridge. Can a car go across?

<table>
<thead>
<tr>
<th>Test #1: Did the Boat Float?</th>
<th>yes</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test #2: Did the Boat Float?</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Test #3: Did the Boat Float?</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>
Lego Boats: Design a boat that will carry 2 small passengers (bears).
It must float for 2 minutes.

Data Collection

<table>
<thead>
<tr>
<th>Trials</th>
<th>Did it float?</th>
<th>Observations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td>yes</td>
<td>Improvements: What changes did you make?</td>
</tr>
<tr>
<td>2 bears</td>
<td>a little</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Trial 2</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>How many bears?</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>_____</td>
<td>a little</td>
<td></td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a little</td>
<td></td>
</tr>
<tr>
<td></td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a little</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td></td>
</tr>
</tbody>
</table>

**Draw your boat design(s):**
Marble Mazes

Legos: Use 10x10 baseboard

Build a marble maze.

A marble moves through the marble maze successfully.

- material
- action
- force/gravity
- teamwork
- plan/build
- test/improve

Build a farm.
Add small farm animals.
Hands On

Towers: Pipe Cleaners

GOAL
Build a freestanding tower.

MATERIALS: 15 pipe cleaners
Optional: Cardboard base to tape tower on before taking home

Architects & Builders
Architects take ideas and turn them into structures. They ask lots of questions and use many basic principles in their designs.

• balance • rhythm • emphasis
• contrast • movement • unity
Adopt & Implement: Next Generation Science Standards
Science & Engineering Practices

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information
STEM Challenge

Engineering Design Process
• Ask (Identify the Problem) • Imagine • Plan • Build • Test/Improve

Goal (Identify problem)

Materials

Science and Engineering Practices (student engagement / outcomes)

NGSS: Science and Engineering Practices
• Asking questions and defining problems
• Developing and using models
• Planning and carrying out investigations
• Analyzing and interpreting data
• Using mathematics and computational thinking
• Constructing explanations and designing solutions
• Engaging in argument from evidence
• Obtaining, evaluating, and communicating information

NGSS: Crosscutting Concepts
1. Patterns
2. Cause and effect: Mechanism and Explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change
<table>
<thead>
<tr>
<th>Books</th>
<th>Architects &amp; Designing w/Craft Materials</th>
</tr>
</thead>
</table>
| **Title:** The Shape of the World A Portrait of Frank Lloyd Wright, K. L. Going  
**Materials:** 15-20 index cards 4x6, masking tape/2-ft.  
**Option:** Design with Jenga or planks, blocks, Magna tiles  
**Goal:** Design with geometric shapes: towers, structures, bridges, etc. Share. Option: Sketch and label/list shapes. |
| **Title:** The World Is Not a Rectangle: A Portrait of Architect Zaha Hadid, Jeannette Winter  
**Materials:** any building or craft materials  
**Goal:** Design a structure with features. Share. Option: Sketch and label. |
| **Title:** Dreaming Up: A Celebration of Building, Christy Hale  
https://www.youtube.com/watch?v=wma1k-ILxrw  
**Materials:** blocks- large, small, magna tiles, Legos, Jenga, planks, clay, cardboard, boxes  
**Goal:** Design a structure from imagination or modeled after real-world structures |
| **Title:** Not a Box, Antoinette Portis  
https://www.youtube.com/watch?v=Nif94VQ4Xsc  
**Materials:** small cardboard boxes (food boxes), paper - any type, pipe cleaners, craft sticks, felt, rubber bands, ...  
**Goal:** Design a purpose w/the small box as the main project: add craft materials to turn it into “Not a Box!” |
| **Title:** Boxitects, Kim Smith  
**Materials:** medium/large cardboard boxes, assorted paper, felt/fabric, paper rolls, craft sticks-wide, thin, straws, ...  
**Goal:** Design something using box(es) as main element and add details |
| **Title:** Going Places, Peter Reynolds  
**Materials:** prep a “mystery kit" with same craft materials for each student  
**Goal:** Design something using the materials in the mystery kit |
| **Title:** The Most Magnificent Thing, Ashley Spires  
**Materials:** small boxes, pipe cleaners, craft sticks, felt, brads, rubber bands, paper rolls, pom poms, ...  
**Goal:** Design a contraption. What does it do? How does it work? Share. Option: Sketch and label. |
| **Title:** Iggy Peck Architect, Andrea Beatty  
**Materials:** index cards, craft sticks, straws, paper clips. **Option:** building materials: blocks, magna tiles, planks  
**Goal:** Design a bridge that supports the weight of a car; small cup of weights (pennies, washers, …). Share. |
<table>
<thead>
<tr>
<th>Materials</th>
<th>Engineering w/Structures</th>
<th>People &amp; Imagination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Float, Daniel Miyares</td>
<td>Bridges Are to Cross, Philemon Sturges</td>
<td>Be a Maker, Katey Howes</td>
</tr>
<tr>
<td>Not a Box, Antoinette Portis</td>
<td>Bridges &amp; Tunnels: Investigating Feats of Engineering, Donna Latham</td>
<td>Extra Yarn, Mac Barnett</td>
</tr>
<tr>
<td>By <a href="https://www.youtube.com/watch?v=Nif94VQ4Xsc">https://www.youtube.com/watch?v=Nif94VQ4Xsc</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not a Stick, Antoinette Portis</td>
<td>Building Bridges, Tammy Enz</td>
<td>Going Places, Paul A. Reynolds</td>
</tr>
<tr>
<td>The Most Magnificent Thing, Ashley Spires</td>
<td>Dreaming Up: A Celebration of Building, Christy Hale</td>
<td>If I Built a House, Chris Van Dusen</td>
</tr>
<tr>
<td>-View a 3-min author interview <a href="https://www.youtube.com/watch?v=wma1k-ILxrw">https://www.youtube.com/watch?v=wma1k-ILxrw</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What if Rain Boots Were Made of Paper Kevin Beals &amp; P. David Pearson</td>
<td>Here to There and Me to You, -Cheryl Keely</td>
<td>In My Room: A Book of Creativity and Imagination, Jo Witek</td>
</tr>
<tr>
<td>What to Do With a Box, Jane Yolen</td>
<td>Building Structures and Towers, Tammy Enz</td>
<td>The Little Red Fort, Brenda Maier</td>
</tr>
<tr>
<td>Woollard: A Little Stitched Book, K.J. Scribbles</td>
<td>Iggy Peck Architect, Andrea Beatty</td>
<td>Notable Notebooks Scientists and Their Writings NSTA</td>
</tr>
<tr>
<td>Woollard in New York City, K.J. Scribbles</td>
<td>Iggy Peck's Big Project Book for Amazing Architects</td>
<td>Rosie Revere Big Project Book, Andrea Beatty</td>
</tr>
<tr>
<td>Woollard at the North Pole, K.J. Scribbles</td>
<td>Look at That Building! Scot Ritchie</td>
<td>Rosie Revere Engineer, Andrea Beatty</td>
</tr>
<tr>
<td>Maya Lin: Artist-Architect of Light and Lines Jeanne Walker Harvey</td>
<td>Violet the Pilot, Steve Breen</td>
<td></td>
</tr>
<tr>
<td>The World Is Not a Rectangle: A Portrait of Architect Zaha Hadid Jeannette Winter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resources</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Vivify</strong> <a href="https://www.vivifystem.com/">https://www.vivifystem.com/</a></td>
<td>Free materials &amp; for purchase, sign up for free resources and access to library w/lessons</td>
<td></td>
</tr>
<tr>
<td><strong><a href="http://discovere.org/">http://discovere.org/</a></strong></td>
<td>STEM Resources/Free Online Activities</td>
<td></td>
</tr>
<tr>
<td><strong><a href="https://thestemlaboratory.com/">https://thestemlaboratory.com/</a></strong></td>
<td>Lots of STEM/Engineering posts, newsletter available, Lego challenge cards</td>
<td></td>
</tr>
<tr>
<td><strong>Teachers are Terrific</strong> <a href="https://www.teacherspayteachers.com/Product/Engineering-Design-Process-Posters-Freebie-888579">https://www.teacherspayteachers.com/Product/Engineering-Design-Process-Posters-Freebie-888579</a></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong><a href="https://www.teacherspayteachers.com/Product/STEM-Engineering-Starter-Kit-for-Teachers-elementary-level-977781">https://www.teacherspayteachers.com/Product/STEM-Engineering-Starter-Kit-for-Teachers-elementary-level-977781</a></strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Dear Parents,

We will be doing a STEM (science, technology, engineering, and math) project in class coming up very soon. Students will be engineering and creating awesome things and we will need some recycled materials to help us out in the classroom. Please send materials in to class as soon as possible. Thank you for your help!

**Recyclable Materials we will need:**
- Cardboard Boxes – all shapes and sizes (Kleenex, cereal, shoe, etc.)
- Paper towel/toilet paper rolls
- Empty Containers
- Egg Cartons
- Pipe Cleaners
- Tin Foil
- Paper plates, cups, bowls
- String, ribbon
- Bubble Wrap
- Lids of any size
- Styrofoam
- Twisty Ties
- in Cans
- -Anything that is clean “trash

**New Materials:**
- Pipe Cleaners
- Popsicle Sticks/Tongue Depressors
- Toothpicks
- Coffee Filters
- Paper/Styrofoam Plates, Cups, trays etc.
- Coffee Stirrers
- Straws
- Cotton Balls
- Q-Tips
- Beads
- Wire
- Tape
- Aluminum Foil
- Saran Wrap

Thank you,