Engineering Your Own Toy AND Your Own Lesson

TEXAS A&M UNIVERSITY®

ETA hand2mind®
hands-on learning for growing minds

2015 Teacher Summit and Leadership Forum

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Scenario

While you are planning lessons, you find a great project idea or learning module – and it does not exactly fit with your grade level, your scope and sequence, or the specific needs of your students.

What could you do?

Possible Solutions

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- Keep looking
- “Tweak/Twist” what you found to meet your need

The tweaking is a form of engineering.

Purpose of this workshop

- Explore an existing STEM learning module around chemistry and toy design (designed for 5th grade)
- Provide you with a process to “tweak” an existing lesson to fit your teaching needs
- Provide us with feedback how we can scale our STEM learning modules into higher grade levels

About the STEM modules

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Hands-On Standards® STEM in Action

- Hands-on activities teach children real-world problem solving and critical thinking skills.
- Approachable, teacher-friendly modules address state standards in Science, Math, and ELA.
- Developed with Texas A&M and Purdue University to create an authentic STEM experience.
- Each series strikes the perfect balance of rigor and ease of use.

Challenge Series

Unpacking the Grades 3–5 Modules

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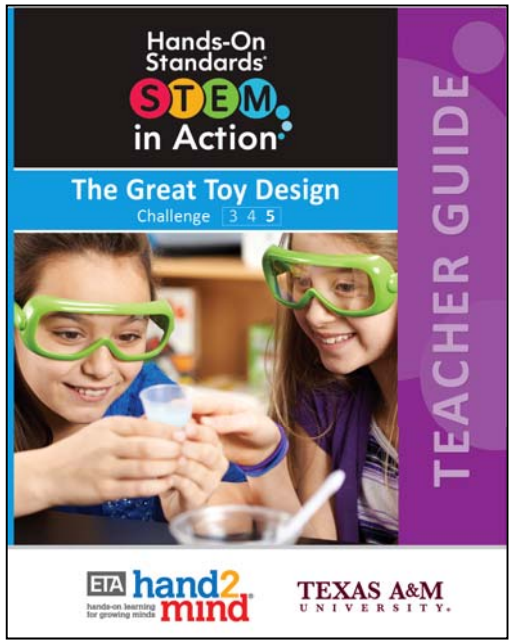


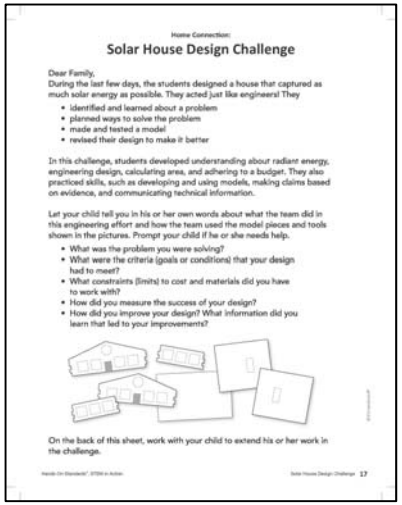
Teacher Guide

Student Activity Books
(6 copies)

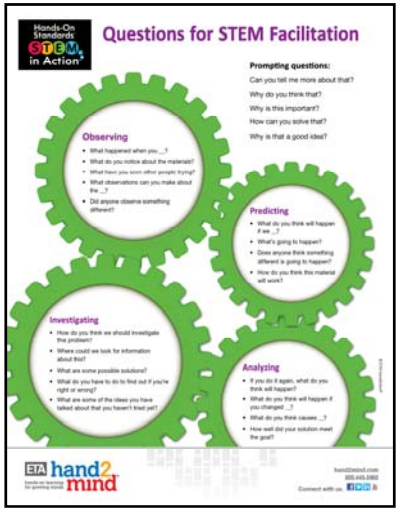
Each module includes the hands-on materials needed for the activities.

Challenge Series

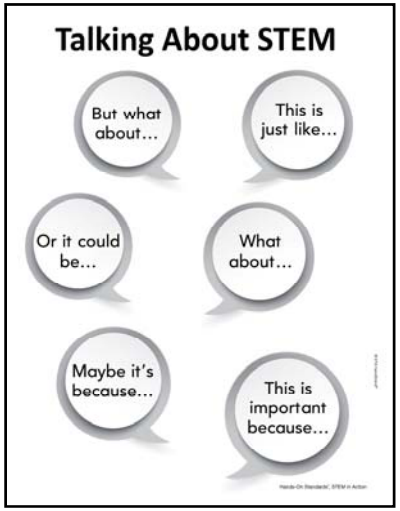
Digital Classroom Resources



Home Connection Parent Letters



STEM Prompts



Teamwork Principles

Facilitating STEM in the Classroom Video

How-To Video

The Great Toy Design Challenge

Grade 5 Challenge Series

- Build understanding of **properties of matter** and **mixtures**.
- Sir Isaac's Toy Company wants to **create a smushy, gooshy children's toy** and needs help in design testing. Student identify materials based on their properties, evaluate competitors' products, and **design a superior product to sell**.

The Great Toy Design Challenge

Grade 5 Challenge Series

- **Science Concepts:** properties of fluids, viscosity, conservation of mass
- **Math Concepts:** compare the size of a product to one factor, solve real-world fractions with multiplication, volume, measurement
- **ELA Concepts:** use precise language, engage in collaborative discussions, write a food critic review

Exercise 1

Let’s explore one activity from the Great Toy Challenge

Define the Problem

Criteria and Constraints

How will you know if your prototype is successful?

Sir Isaac's wants your new toy to meet four **criteria**, or conditions that can be measured. Your prototype must

- ☑ Flow at least 1 centimeter in 5 minutes
- ☑ Bounce at least 7 centimeters
- ☑ Stretch at least 30 centimeters without breaking apart
- ☑ Not leave a sticky mess

Sir Isaac's also has set some limits on your solution to the problem. The formula for your toy must stay within these **constraints**. Your formula must

- ☑ Contain only these ingredients: glue, sodium borate, liquid starch (You may use two or three of these ingredients.)
- ☑ Contain no more than 20 milliliters of sodium borate
- ☑ Make between 30 and 50 milliliters of product
- ☑ Flow less than 2 centimeters in 1 minute.

Plan Solutions

Define the Problem

Plan Solutions

Make a Prototype

Test the Prototype

Reflect and Redesign

Test a Competitor's Toy

The toy you develop for Sir Isaac's will compete with toys made by other companies. Your main competitor is a toy called Big Bouncer. Your new toy must be better!

You and your team will test a sample of Big Bouncer to determine some of its physical properties. The tests will help you answer these questions:

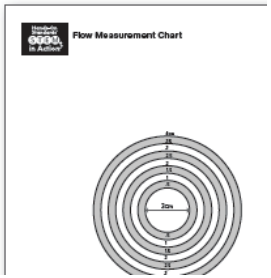
- How quickly does Big Bouncer flow?
- How high does a ball of Big Bouncer bounce?
- How far does a cylinder of Big Bouncer stretch?
- Does Big Bouncer leave a sticky mess?

Plan Solutions

Test a Competitor's Toy

Viscosity Test

1. Put on gloves.
2. Use enough of the sample of Big Bouncer to make a ball that has a **diameter** of 3 centimeters.
3. Place the ball in the center circle on the **Flow Measurement Chart**.
4. Start the timer.
5. After 5 minutes, stop the timer.
6. Use a dry erase marker to trace around the mixture on the **Flow Measurement Chart** and measure how far it flowed.
7. Record this distance in the data table on the **Test Big Bouncer** page.



Plan Solutions

Test a Competitor's Toy

Bounce Test

1. Place a piece of wax paper on a table. Put on gloves.
2. Use your hands to form the sample of Big Bouncer into a ball with a diameter of 3 centimeters. Roll the ball on the wax paper to make it as round and smooth as you can.
3. Hold a ruler upright. Position the ball so the bottom of the ball is 15 centimeters above the table.
4. **Observe** Drop the ball. How high does the ball bounce?

5. Drop the ball three times and observe how high it bounces each time.
6. Circle the greatest height that the ball bounced on the **Test Big Bouncer** page.

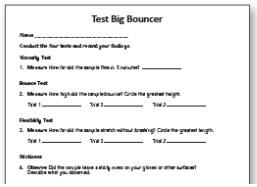
Materials

Big Bouncer sample

Wax paper

Gloves

Metric ruler



Plan Solutions

Test a Competitor's Toy

Flexibility Test

1. Place a piece of wax paper on a table. Put on gloves.
2. Roll some of the sample of Big Bouncer into a cylinder that is 1 centimeter in diameter and 8 centimeter long. (If the cylinder is too long, cut it to the correct length.)

3. Lay the measuring tape across the table. Hold the ends of the cylinder and gently pull.

4. **Measure** the length that you are able to stretch the cylinder. Subtract 8 centimeters (the starting length) from the final length. Record the difference on the **Test Big Bouncer** page.
5. Repeat two more times because sometimes results change with practice.

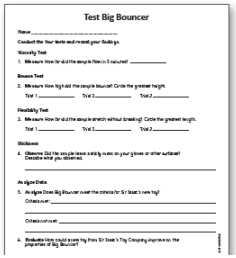
Materials

Big Bouncer sample

Wax paper

Gloves

Measuring tape



Plan Solutions

Test a Competitor's Toy

Stickiness

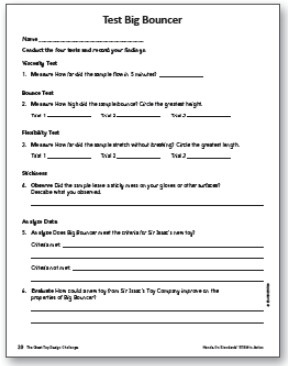
1. When you finish conducting the tests, observe your gloves and the wax paper.
2. Did the sample of Big Bouncer make your gloves feel sticky? Was any of the material left on your gloves or on the wax paper?
3. Record your observations on the **Test Big Bouncer** page.

Analyze Results

Look back at the results of the four tests. Then answer the questions on the **Test Big Bouncer** page. Review Sir Isaac's criteria for your new toy.

- How closely did the Big Bouncer meet Sir Isaac's criteria?
- In what ways could a new toy from Sir Isaac's be better than Big Bouncer?

Materials



Test Big Bouncer

Let's tweak it for your grade level

Standards:

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Grade 5 (TEKS)	Grade 10, 11, 12 (TEKS) - Chemistry
Scientific Processes. Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:	**Scientific processes**. The student conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:
Describe, plan, and implement simple experimental investigations testing one variable.	Plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including
And many more sub-processes are parallel	And many more sub-processes are parallel
Scientific concepts. Classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water, and the ability to conduct or insulate thermal energy or electric energy.	**Scientific concepts**. (A) differentiate between physical and chemical changes and properties; (B) identify extensive and intensive properties; (C) compare solids, liquids, and gases in terms of compressibility, structure, shape, and volume; and (D) Classify matter as pure substances or mixtures through investigation of their properties.
Demonstrate that some mixtures maintain physical properties of their ingredients such as iron filings and sand.	Energy changes that occur in chemical reactions and its sub-concepts

Let's tweak it for your grade level

Grade 5 (TEKS)	Grade 10, 11, 12 (TEKS) – Integrated Physics and Chemistry (§112.38 (6))
Scientific Processes. Scientific investigation and reasoning. The student uses scientific methods during laboratory and outdoor investigations. The student is expected to:	**Scientific processes**. The student conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:
Describe, plan, and implement simple experimental investigations testing one variable.	Plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including
And many more sub-processes are parallel	And many more sub-processes are parallel
Scientific concepts. Classify matter based on physical properties, including mass, magnetism, physical state (solid, liquid, and gas), relative density (sinking and floating), solubility in water.	**Scientific concepts**. analyze physical and chemical properties of elements and compounds such as color, density, viscosity, buoyancy
Demonstrate that some mixtures maintain physical properties of their ingredients such as iron filings and sand.	Examine differences in physical properties of solids, liquids, and gases as explained by the arrangement
	Relate the structure of water to its function as a solvent and investigate the properties of solutions and factors affecting gas and solid solubility, including nature of solute, temperature, pressure, pH, and concentration.

Process of tweaking

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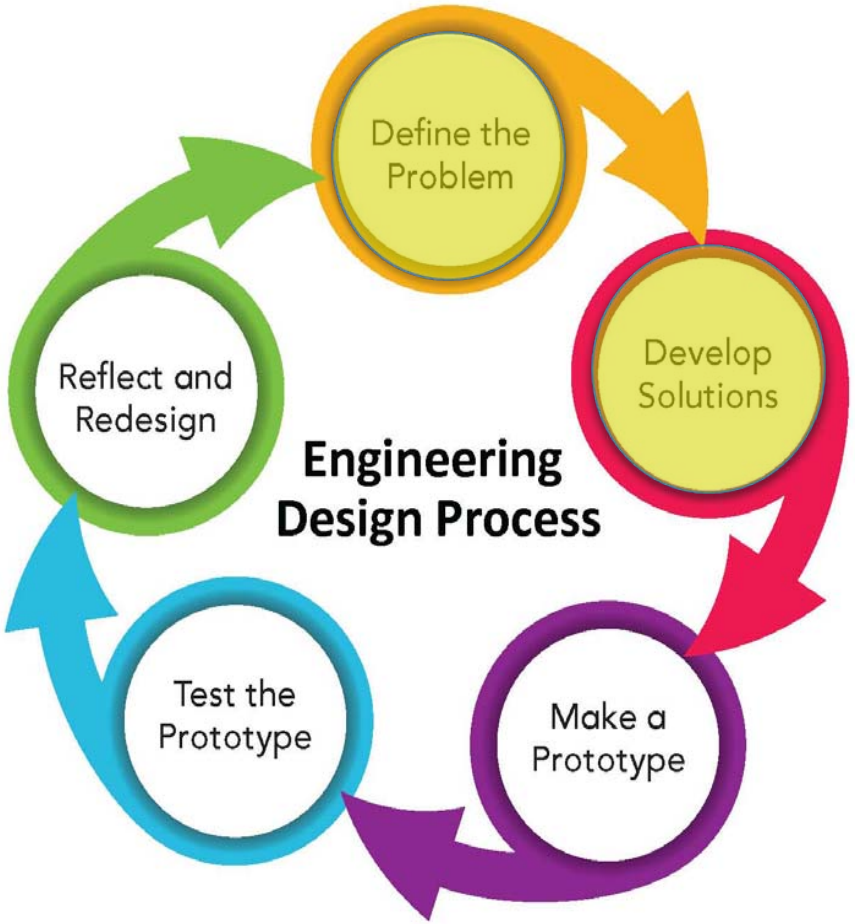

Define and Develop

- Define the problem (upgrade module use for grade 10-12)
  - Identify strengths of the module
  - Identify weaknesses of the module
- Develop solutions (in small teams)
  - Discuss possible solutions
  - Discuss continued worries

Record your recommendations—please turn them in!

What's next?

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- Your feedback is invaluable
- Are you interested in working on this further (be involved in beta-testing, for example)?
- How helpful was this workshop in providing you with a tool to start thinking about upgrading a learning module?

Thank you!

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