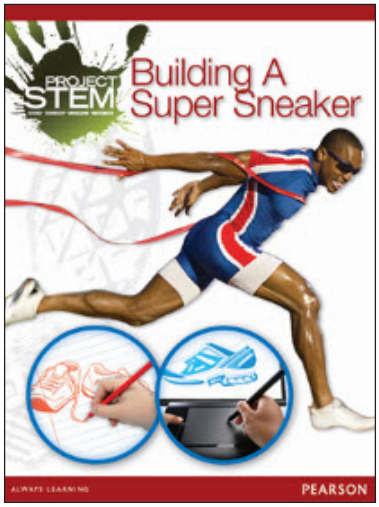
PROJECT STEM
SCIENCE • TECHNOLOGY • ENGINEERING • MATHEMATICS
today's students tomorrow's innovators

Program Overview: Grades 3–5

Introduction

This guide introduces Project STEM for Grades 3–5. It explores STEM subjects—science, technology, engineering, and mathematics—and identifies factors that have led to an increased emphasis on STEM education.

This guide also examines how to integrate STEM instruction into your existing science and math curriculum. It identifies program tools and strategies for planning and assessing STEM instruction.



What is STEM education?

What is STEM education, and why is it so important for our students and for the future progress of our nation?

The world is changing rapidly. Every day there are advances in science and engineering. The STEM fields—science, technology, engineering, and mathematics—are interconnected and at the core of these innovations.

STEM Initiative

The STEM fields are building blocks to our economy and society. Politicians, educators, and economists have become increasingly concerned that many STEM jobs have relocated from the United States to foreign countries, that fewer of our students are choosing to enter the STEM fields of study; and that our students perform poorly on STEM subjects during international testing.

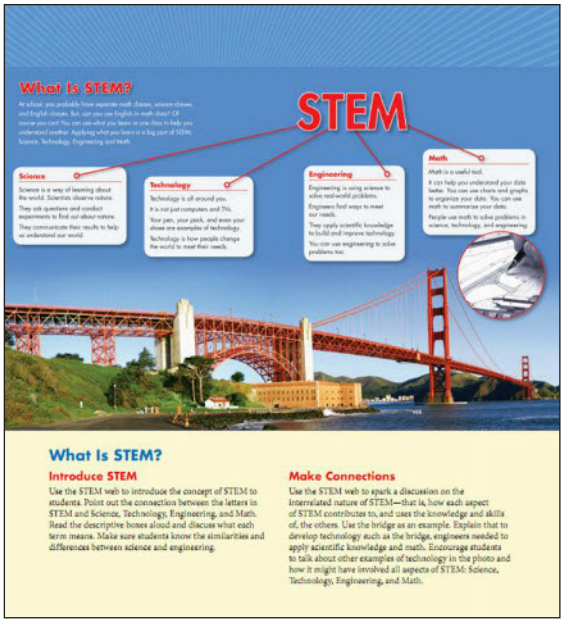
As a result, the US government developed the STEM initiative—a coalition to raise awareness about the critical role that STEM education plays in enabling the United States to remain the economic and technological leader of the global marketplace of the 21st century. Increasingly, educational programs support this initiative.

STEM Education

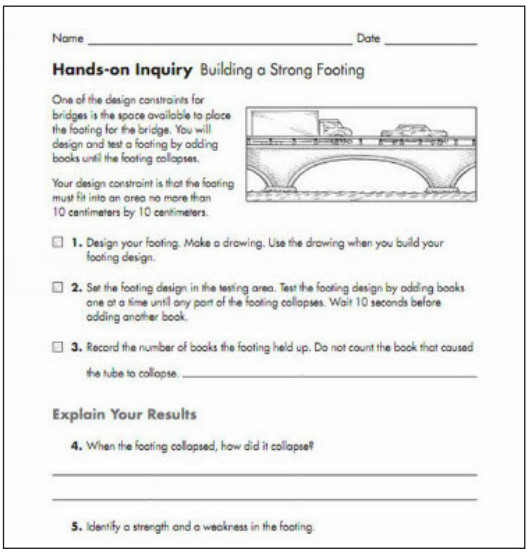
The STEM education movement recognizes that your students are the nation's future scientists and engineers. Students need opportunities to integrate these fields of study so that they develop the necessary skills to be competitive and successful in a rapidly changing world economy.

Project STEM

Project STEM prepares your students for advanced and rigorous coursework in the STEM fields. Inquiry and project-based activities easily integrate with your science or math curriculum.



The program activities are also appropriate for after-school programs, school clubs, and summer programs.



Name _____ Date _____

Hands-on Inquiry Building a Strong Footing

One of the design constraints for bridges is the space available to place the footing for the bridge. You will design and test a footing by adding books until the footing collapses.

Your design constraint is that the footing must fit into an area no more than 10 centimeters by 10 centimeters.

☐ **1.** Design your footing. Make a drawing. Use the drawing when you build your footing design.

☐ **2.** Set the footing design in the testing area. Test the footing design by adding books one at a time until any part of the footing collapses. Wait 10 seconds before adding another book.

☐ **3.** Record the number of books the footing held up. Do not count the book that caused the tube to collapse. _____

Explain Your Results

4. When the footing collapsed, how did it collapse?

_____

_____

5. Identify a strength and a weakness in the footing.

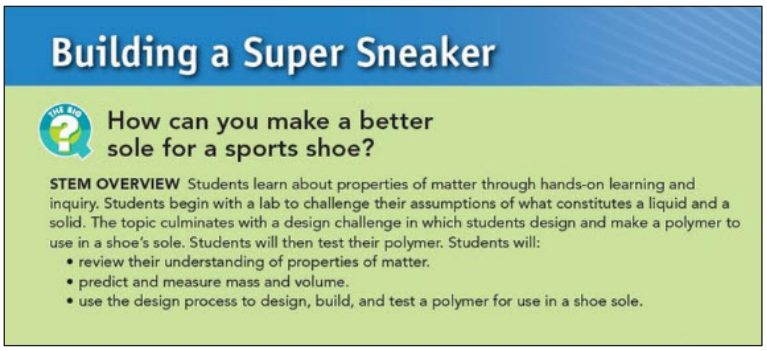
Program Components (Grades 3–5)

The program is available for Grades K–8. For Grades 3–5, there are three flip-books, each featuring two modules: Designing Bird Feeders/ Building a Spirometer, Building for Erosion Control/Designing a Greener Cleaner, and Building a Super Sneaker/Designing Bridges.

Prepackaged materials kits are available for each module. The modules follow the same instructional format: Introduce the topic, Teach, and Evaluate.

Big Question

The program introduces each topic with a Big Question. This question is a conversation starter that gives students a purpose for studying the topic. The STEM overview provides the student goals.



Building a Super Sneaker

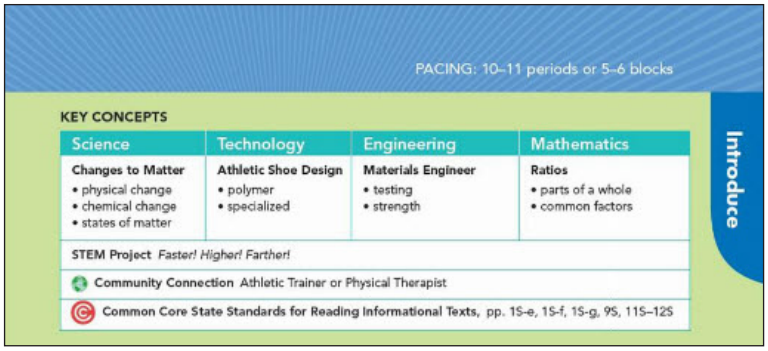
How can you make a better sole for a sports shoe?

STEM OVERVIEW Students learn about properties of matter through hands-on learning and inquiry. Students begin with a lab to challenge their assumptions of what constitutes a liquid and a solid. The topic culminates with a design challenge in which students design and make a polymer to use in a shoe's sole. Students will then test their polymer. Students will:

- review their understanding of properties of matter.
- predict and measure mass and volume.
- use the design process to design, build, and test a polymer for use in a shoe sole.

Key Concepts

The Key Concepts table provides you with cross-curricular correlations that you can use to integrate STEM modules with the lessons that you already teach. Not only does it provide topics for STEM fields of study but it also provides correlations to the Common Core State Standards for Reading Informational Texts.



PACING: 10–11 periods or 5–6 blocks

Introduce

KEY CONCEPTS

Science	Technology	Engineering	Mathematics
Changes to Matter • physical change • chemical change • states of matter	**Athletic Shoe Design** • polymer • specialized	**Materials Engineer** • testing • strength	**Ratios** • parts of a whole • common factors

STEM Project *Faster! Higher! Farther!*

Community Connection Athletic Trainer or Physical Therapist

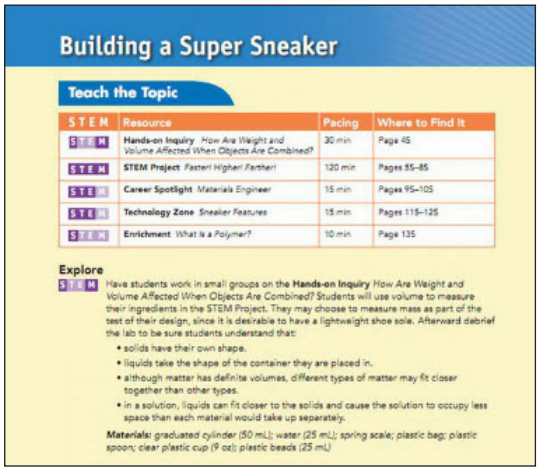
Common Core State Standards for Reading Informational Texts, pp. 1S-e, 1S-f, 1S-g, 9S, 11S–12S

Introduce

Continue to introduce the topic with Vocabulary Practice, Math Practice, and a Quick Lab. These features help prepare your students with the background knowledge and skills they need to successfully complete the STEM Project.

Teach

After your students have engaged in learning and have explored the topic, teach the concepts in depth.



Building a Super Sneaker

Teach the Topic

STEM	Resource	Pacing	Where to Find It
STEM	**Hands-on Inquiry** *How Are Weight and Volume Affected When Objects Are Combined?*	30 min	Page 4S
STEM	**STEM Project** *Faster! Higher! Farther!*	120 min	Pages 5S–8S
STEM	**Career Spotlight** *Materials Engineer*	15 min	Pages 9S–10S
STEM	**Technology Zone** *Sneaker Features*	15 min	Pages 11S–12S
STEM	**Enrichment** *What Is a Polymer?*	10 min	Page 13S

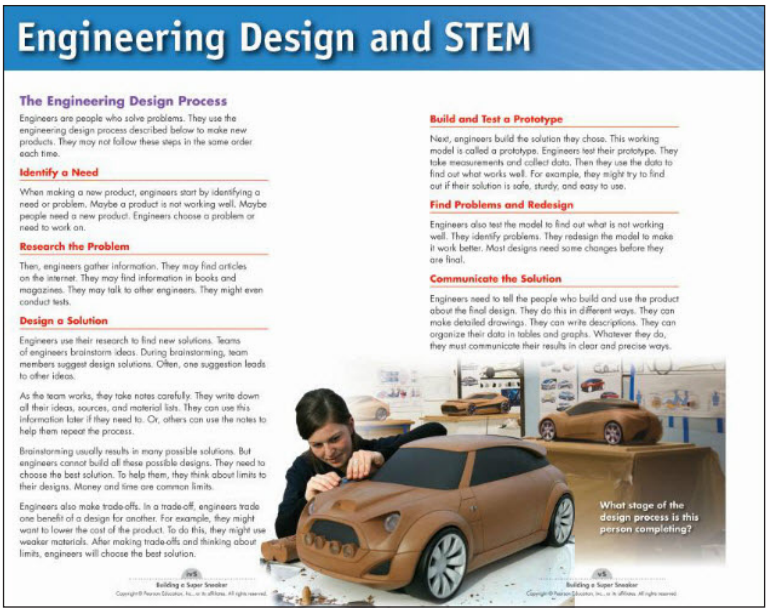
Explore

STEM Have students work in small groups on the **Hands-on Inquiry** *How Are Weight and Volume Affected When Objects Are Combined?* Students will use volume to measure their ingredients in the STEM Project. They may choose to measure mass as part of the test of their design, since it is desirable to have a lightweight shoe sole. Afterward debrief the lab to be sure students understand that:

- solids have their own shape.
- liquids take the shape of the container they are placed in.
- although matter has definite volumes, different types of matter may fit closer together than other types.
- in a solution, liquids can fit closer to the solids and cause the solution to occupy less space than each material would take up separately.

Materials: *graduated cylinder (50 mL); water (25 mL); spring scale; plastic bag; plastic spoon; clear plastic cup (9 oz); plastic beads (25 mL)*

You can facilitate learning as students create and design their own solutions to real-world problems. Through STEM project-based learning, students work together to complete the engineering design process. They choose materials, brainstorm designs, build and test prototypes, revise their designs, and communicate solutions.



Engineering Design and STEM

The Engineering Design Process

Engineers are people who solve problems. They use the engineering design process described below to make new products. They may not follow these steps in the same order each time.

Identify a Need

When making a new product, engineers start by identifying a need or problem. Maybe a product is not working well. Maybe people need a new product. Engineers choose a problem or need to work on.

Research the Problem

Then, engineers gather information. They may find articles on the internet. They may find information in books and magazines. They may talk to other engineers. They might even conduct tests.

Design a Solution

Engineers use their research to find new solutions. Teams of engineers brainstorm ideas. During brainstorming, team members suggest design solutions. Often, one suggestion leads to other ideas.

As the team works, they take notes carefully. They write down all their ideas, sources, and material lists. They can use this information later if they need to. Or, others can use the notes to help them repeat the process.

Brainstorming usually results in many possible solutions. But engineers cannot build all these possible designs. They need to choose the best solution. To help them, they think about limits to their designs. Money and time are common limits.

Engineers also make trade-offs. In a trade-off, engineers trade one benefit of a design for another. For example, they might want to lower the cost of the product. To do this, they might use weaker materials. After making trade-offs and thinking about limits, engineers will choose the best solution.

Build and Test a Prototype

Next, engineers build the solution they chose. This working model is called a prototype. Engineers test their prototype. They take measurements and collect data. Then they use the data to find out what works well. For example, they might try to find out if their solution is safe, sturdy, and easy to use.

Find Problems and Redesign

Engineers also test the model to find out what is not working well. They identify problems. They redesign the model to make it work better. Most designs need some changes before they are final.

Communicate the Solution

Engineers need to tell the people who build and use the product about the final design. They do this in different ways. They can make detailed drawings. They can write descriptions. They can organize their data in tables and graphs. Whatever they do, they must communicate their results in clear and precise ways.

What stage of the design process is this person completing?

STEM Project Support

Each topic has four key components to support teaching and learning the STEM Project.

The Hands-on Inquiry labs give students an additional, interactive opportunity to build STEM topic knowledge and skills.

The Career Spotlight prepares your students for the 21st century job force by highlighting careers that build on and apply what they have learned in the STEM Project.

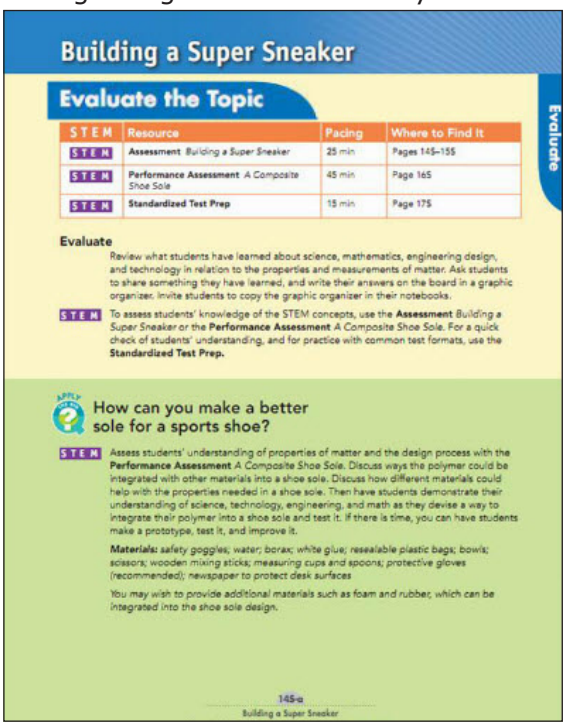
The Technology Zone showcases the integration of technology, science, and engineering by highlighting important innovations related to the STEM Project.

The Enrichment Activities expand your students' knowledge and skills in areas related to the STEM Project.

Evaluate

Every topic also contains three assessment opportunities—a traditional Assessment, a project-based Performance Assessment, and Standardized Test Prep practice.

The assessments align to the Common Core State Standards and to the Standards for Technological Literacy—content for the study of technology in K–12 education. Use these assessments for practice in taking the Common Core assessments and to evaluate your students' progress in becoming college and career ready.



Building a Super Sneaker

Evaluate the Topic

STEM	Resource	Pacing	Where to Find It
STEM	**Assessment** *Building a Super Sneaker*	25 min	Pages 145–155
STEM	**Performance Assessment** *A Composite Shoe Sole*	45 min	Page 165
STEM	**Standardized Test Prep**	15 min	Page 175

Evaluate

Review what students have learned about science, mathematics, engineering design, and technology in relation to the properties and measurements of matter. Ask students to share something they have learned, and write their answers on the board in a graphic organizer. Invite students to copy the graphic organizer in their notebooks.

STEM To assess students' knowledge of the STEM concepts, use the **Assessment** *Building a Super Sneaker* or the **Performance Assessment** *A Composite Shoe Sole*. For a quick check of students' understanding, and for practice with common test formats, use the **Standardized Test Prep.**

How can you make a better sole for a sports shoe?

STEM Assess students' understanding of properties of matter and the design process with the **Performance Assessment** *A Composite Shoe Sole*. Discuss ways the polymer could be integrated with other materials into a shoe sole. Discuss how different materials could help with the properties needed in a shoe sole. Then have students demonstrate their understanding of science, technology, engineering, and math as they devise a way to integrate their polymer into a shoe sole and test it. If there is time, you can have students make a prototype, test it, and improve it.

Materials: *safety goggles; water; borax; white glue; resealable plastic bags; bowls; scissors; wooden mixing sticks; measuring cups and spoons; protective gloves (recommended); newspaper to protect desk surfaces*

You may wish to provide additional materials such as foam and rubber, which can be integrated into the shoe sole design.

145a
Building a Super Sneaker

Review

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