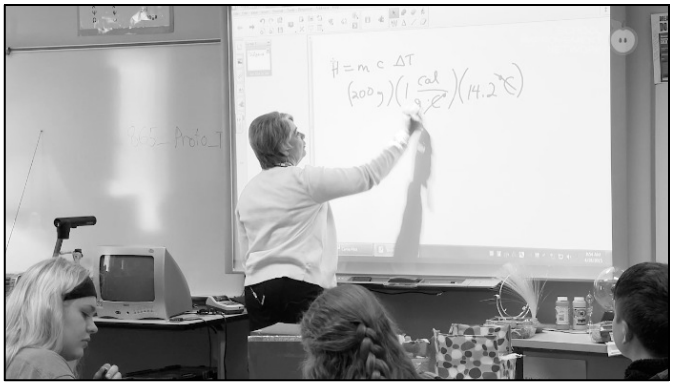
Investigating the Efficiency of Insulation

STEM: Science, Technology, Engineering, Mathematics



STEM Classroom Series

The STEM Classroom Series features lessons that promote understanding of STEM content knowledge, integrate STEM with non-STEM subjects, and increase students' exposure to STEM-related career options.

About This Segment

In STEM education, students conduct experiments to better understand their world. At the Weber Innovation Center in Ogden, Utah, Ms. Holly Barker's pre-engineering students are tasked with building an efficient insulated container for a can of hot water and calculating the rate of heat loss.

Application activities (complete all that meet your goals for viewing this segment)

A. Learn more about STEM education

1. In the table on the next page, identify the elements of effective instruction, as well as the elements of effective STEM instruction, that you observed in this lesson.

2. How could the teachers enhance or add to the elements of instruction in their lesson?

3. How could the teachers enhance or add to the elements of STEM instruction?

C. Infuse STEM principles into your own lessons

1. Apply the six questions in the "Replicate this lesson" activity to one of your own lessons.

2. Determine challenges you might face in applying these STEM concepts to your own lesson. How can you overcome these challenges?

B. Replicate this lesson

1. *What are the learning objectives you want your students to achieve?*
   How would you modify the lesson's objectives, outlined in the Lesson Plan below, for your own students and curriculum? What other objectives, if any, will you set?

2. *What content knowledge do you need to acquire or expand?*
   This activity teaches students about heat loss. What of this concept do you need to learn more about? Visit the Resources to Support Content Knowledge links in the Lesson Plan section of this guidebook.

3. *How will you create the time and space to engage students in this lesson?*
   How much time will this learning activity take to plan and carry out? How can you integrate the activity into your current curriculum map?

4. *What materials and other resources do you need for this lesson?*
   What materials are needed for this lesson? See the Materials section of the Lesson Plan. What collaboration is necessary with administrators and other teachers?

5. *How will you assess student learning?*
   Students will plot their data on a line graph and write a brief technical paper to explain their findings. How else might you assess student learning?

6. *How can you promote a STEM focus in your instruction?*
   What STEM experiences were students engaged in during this lesson? (See the "Elements of Effective STEM Instruction" below.) What are some others that you could include?

Elements of Effective Instruction	Elements of Effective STEM Instruction
- High expectations for all students - Rigorous content - Authentic performance tasks - Real-time assessment adapted to student needs - Student-driven learning - Strong relationships among students and between teacher and students - Equitable, culturally relevant content and practices - Evidence of 21st century skills, e.g. critical thinking, problem solving, collaboration, creativity, communication - Technology that enhances learning - Cross-curricular (interdisciplinary) integration	*In addition to the Elements of Effective Instruction left, effective STEM instruction can include:* - Teachers who develop solid STEM-related content knowledge - Hands-on problem-solving activities that have real-world relevance - Integration of STEM into non-STEM subjects, especially art and design - Use of industry-standard software, tools, and procedures such as the engineering design cycle - Increased awareness of STEM fields and occupations, especially among underrepresented populations - Enthusiasm about further STEM-related learning - Connections between in-school and out-of-school learning opportunities - Industry and higher-ed partnerships that encourage hands-on student exploration of STEM-related careers

Sources: California Dept. of Education. (2015). Science, technology, engineering, & mathematics. Retrieved February 21st, 2015, from http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp

President's Council of Advisors on Science and Technology (PCAST). (2010). Prepare and inspire: K-12 education in science, technology, engineering, and math (STEM) for America's future. Retrieved from the Whitehouse.gov website: http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

General STEM Information and Resources

Utah STEM Action Center (n.d.). STEM Utah. Retrieved January 22, 2015, from http://stem.utah.gov/

California Department of Education (n.d.). Science, technology, engineering, and mathematics. Retrieved January 22, 2015, from http://www.cde.ca.gov/pd/ca/sc/stemintrod.asp

National Education Association. (n.d.). The 10 best STEM resources: Science, technology, engineering & mathematics resources for preK-12. Retrieved March 23, 2015, from http://www.pbs.org/teachers/stem/

National Research Council. (2011). Successful K-12 STEM Education: Identifying Effective Approaches in Science, Technology, Engineering, and Mathematics. Retrieved March 23, 2015, from http://www.stemreports.com/wp-content/uploads/2011/06/NRC_STEM_2.pdf

PBS Teachers. (n.d.). STEM education resource center. Retrieved March 23, 2015, from http://www.pbs.org/teachers/stem/

STEM Education Coalition (n.d.). Home page. Retrieved January 22, 2015, from http://www.stemedcoalition.org/

Investigating the Efficiency of Insulation — Lesson Plan

Teacher: Holly Barker	**Grade/Content Area**: HS Engineering
School: Weber Innovation Center, Ogden, Utah	**Lesson Duration**: 45 min.

Lesson Objective(s)

Students will understand that some materials are better insulators than others.

Key Concepts and Vocabulary

(See below for online resources that support content knowledge)

• Heat transfer

• Conduction, convection, and radiation

Standard Addressed in the Lesson

Investigate the transfer of heat energy by conduction, convection, and radiation.

Assessment

Students will plot their data on a line graph and explain their findings in a brief technical paper.

Prior Knowledge and Skills

Knowledge: Students learned about thermal energy and conduction, convection, and radiation in a previous class. They also learned the equations to calculate the transfer of energy.

Skills: Students need to be able to measure precisely and convert basic units of measure.

Materials

Each student will need the following:

- A self-constructed light-weight, 30 cm^3 “hot house” made from any material
- 12 oz. soda-pop can
- 200 ml of hot water
- Thermometer
- Ruler
- Scale
- Stopwatch
- Graph paper
- Calculator
- Computer or personal device

Lesson Procedures

Students were tasked with making a "hot house" device out of any material they could find as homework the previous day. The device cannot exceed 30 cm^3 and should be as lightweight as possible.

During the activity students will do the following:

1. Weigh device and can, measuring in grams.
2. Find the average thickness of insulation.
3. Measure the temperature of the room.
4. Pour 200 ml of hot water into the can. Place can in device and measure initial temperature of water.
5. Measure the temperature of the water every 10 minutes for 30 minutes.
6. Plot the water's temperature on a line graph.
7. Calculate the heat flow rate of device using H=mcΔT, M being the mass of the water (200g), C being the specific heat of water (1 calorie or 4.18 joules/g•C°), and ΔT being the change in water temperature.
8. Find the heat flow rate per second.
9. On a computer or sheet of paper separate from the line graph, write a 3-paragraph technical paper describing the device, data, and how it can be applied to building a house.

Differentiating the Instruction

Since students build their own "hot house" device, they determine their own difficulty level by how complex the device is. Students who struggle with unit conversion can start the project measuring in centimeters, Celsius, and calories. Students who are comfortable with unit conversion should start the project measuring in inches, Fahrenheit, and joules.

Resources to Support Content Knowledge

ChemWiki. (n.d.). Thermal energy. Retrieved July 22, 2015, from the University of California, Davis website: http://chemwiki.ucdavis.edu/Physical_Chemistry/Thermodynamics/State_Functions/THERMAL_ENERGY

RapidTables. (n.d.). Calories to joules conversion. Retrieved July 22, 2015, from http://www.rapidtables.com/convert/energy/Calorie_to_Joule.htm

Related Video Lessons and Resources

11th-12th grade chemistry: Investigating thermodynamics 1: Melting ice. Edivate. https://pd360.com/#resources/videos/7669

11th-12th grade chemistry: Investigating thermodynamics 2: Burning marshmallows. Edivate. https://pd360.com/#resources/videos/7670