

Home Energy Efficiency Improvement

Subject Area: Physical Science

Grade Levels: 8th

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Date: To be taught during September 2011

Lesson Overview

In this lesson students will learn how topics related to investigation and experimental design can be applied to the real world example of improving the efficiency of a home heating and air system. After being introduced to the concept of problem solving and the scientific method, students will be presented with a specific process in which technicians evaluate various aspects of a home's heating and air system and later make improvements which will increase the home's overall efficiency. Students will then work in groups, evaluating the efficiency of a section of duct, attempting to make alterations which will improve the efficiency, then re-evaluate the efficiency of the improved system. Finally, students will compete with other groups by comparing the numerical value of their improvements and presenting their findings to their class. The winning group will be determined by combining the lab results with their presentation.

Student Materials Required for this Lesson

- PowerPoint Introduction
- Lab sheets
- Inefficient (leaky) duct section
- Poster creation supplies
- Improvement supplies

Other Materials Required for this Lesson

- Testing system (fan, wind turbine, power output testing device)
- Sample poster
- Introductory presentation

Skills the Student will Learn

- Plan and conduct a scientific investigation to test a hypothesis.
- Evaluate the accuracy and reproducibility of data.
- Distinguish between variable and controlled parameters in a test.
- Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

Student Deliverables

- Completed lab report with data table, graphs, and answered questions
- Poster and oral presentation

Length of Lesson: 5 Days

Activity Day One

Introductory presentation: Students will have already been introduced to the scientific process. Students will now see a presentation on the application of the scientific process to the testing and improvement of a home heating and air system. Presentation will include video and documents taken during the summer externship with the Beutler Corporation.

Activity Day Two

Lab Activity—Testing and Improvement of duct sample: Students will be supplied a damage sample of heating/air duct. Students will test the efficiency of their sample and record their data. Each group will then make improvement using a limited set of supplies.

Activity Day Three

Lab Activity—Final Improvement of duct sample and retesting: Students will retest their improved duct sample and record the new data. Students will use the initial and final data to construct graphs and compare them to answer questions on their individual supplied lab sheets.

Activity Day Four

Presentation construction—Students will work in their testing groups and create a poster which will be presented to the class the following day. The poster must include written sections which describe the project and tables and graphs which describe their data.

Activity Day Five

Student Presentations—Students will present their posters as well as evaluate their classmates using supplied rubrics. Grading rubrics will be collected and the winning groups will be announced the following day. Winning groups as well as any individual student that scores a perfect grade on the project will be invited to the Externship dinner December 8th.

Enrichment Suggestions

Interested students will be given the opportunity to further explore maximizing efficiency of various projects at an after school MESA program (Mathematics, Engineering, Science, Achievement).

Student Resources

Students will be given access to the internet on the fourth day of the lesson in order to do any relevant research needed to develop their poster presentation.

California Academic Standards

Investigation and Experimentation (Grade 8)

9. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
 - a. Plan and conduct a scientific investigation to test a hypothesis.
 - b. Evaluate the accuracy and reproducibility of data.
 - c. Distinguish between variable and controlled parameters in a test.
 - d. Recognize the slope of the linear graph as the constant in the relationship $y=kx$ and apply this principle in interpreting graphs constructed from data.
 - e. Construct appropriate graphs from data and develop quantitative statements about the relationships between variables.

Foundation Standards

- 2.5. Use a variety of methods to explain mathematical reasoning
- 2.6. Express the solution clearly and logically...in both verbal and symbolic work

Pathway Standards

- Written and oral language, 1.4. produce legible work
- Listening and speaking, 2.3. deliver research presentations

Lesson Plan Relevance To Externship

Students will understand how their learned standard based curricula can be applied to real industry applications. Students will be exposed to a possible career choice and relevant training program offered by a local community college. Ideally a Beutler employee that has gone through the community college training program will visit the class and make a brief presentation (and test the efficiency of the room if possible).

Rubric for the Home Energy Efficiency Improvement Project

Student Deliverables	4 Exceeds Expectations	3 Meets Expectations	2 Approaches Expectations	1 Fails to meet Expectations
Lab Report	All answers are: <ul style="list-style-type: none"> • Complete and correct • Complete sentences • Neatly written with no extra marks 	Answers are mostly: <ul style="list-style-type: none"> • Complete and correct • Complete sentences • Neatly written 	<ul style="list-style-type: none"> • Most questions are answered • Lab report is written legibly 	<ul style="list-style-type: none"> • Many questions are unanswered or incorrect • Lab report is messy and/or illegible
Oral Presentation	Strongly involved in the groups presentation with at least one full minute speaking	Somewhat involved with the group presentation with at least 30 seconds of speaking	Little involvement in group presentation with at least a small speaking role	No involvement in group presentation with no speaking
Group Poster	Poster is clearly laid out, has a thorough description of the project, makes good use of data tables and graphs, and includes additional resources not supplied by the teacher	Poster is clearly laid out, has a description of the project, and includes complete data tables and graphs	Poster includes an attempt at a description of the project and tries to use data table and graphs, though incorrectly	Poster portion of the project is absent or very incomplete and unable to be followed

Physical Science

Name: _____

Energy Efficiency Improvement

Date: _____ Period: _____

On a hot day, everybody wants to be in a room with cold air, but that cold air can be expensive. Some families spend close to \$1,000 dollars each month during the summer to keep their houses cool! Using less energy can save both money and the environment. Some businesses work to make homes use less energy, saving people money and protecting the environment at the same time.



- 1. Ask a Question:** How can I improve the efficiency of a home's heating and air conditioning system?
- 2. Form a hypothesis:** Complete the following "If...then..." statement by predicting whether or not you can less energy by spending more money to improve an air conditioning system.

"If I spend more money to improve a home's air conditioning system, then _____"

- 3. Test the hypothesis:**
 - Working in groups with the help of the teacher, test the initial efficiency of your HVAC (heating, ventilation, air conditioning) duct. Record your initial results.
 - Using only the supplies provided, make improvements to your group's duct (*hint: try to use as much as the wind energy from the fan as possible*).
 - Retest your group's duct and record your results for trial 1.
 - Repeat steps 1-3 two more times using the additional supplies you are given, recording your results for Trial 2 and Trial 3.

Trial Number	Power Reading	Calculating efficiency	Efficiency Improvement
Initial	(box A)	(n/a) not applicable	(n/a) not applicable
Trial 1 (supplies: \$100)	(box B)	$(\text{box B}/\text{box A}) - 100 = \rightarrow$	
Trial 2 (supplies: \$200)	(box C)	$(\text{box C}/\text{box A}) - 100 = \rightarrow$	
Trial 3 (supplies: \$300)	(box D)	$(\text{box D}/\text{box A}) - 100 = \rightarrow$	

4. Analyze the data: Graph your results.

Title: _____

**Percent Efficiency Improvement
(units)**

Cost of improvements (dollars)

5. Draw a conclusion:

Did your results support or reject your hypothesis? Why or why not (use a complete sentence)?

6. Communicate Results: compare your results with the group next to you. Were your results similar? _____ **Explain why or why not?** (use a complete sentence)

Questions:

In your opinion, if you continued to spend more money of supplies, would you continue to make your system more efficient? Why or why not?

Points	0.5	1	1.5	2
Writing (always use complete sentences)	My answers were not clear and had serious errors in writing mechanics (spelling, grammar, etc.).	My answers gave little explanation using few facts and had several errors in writing mechanics.	My answers gave some explanation using relevant facts and had few errors in writing mechanics.	My answers were clearly explained using relevant facts and used proper writing mechanics.

