



GREEN BUILD 1
in Whyville

CAREER FOCUS

Home Energy Technician

ACADEMIC FOCUS

Understanding kilowatt-hours and their relationship to Energy Star ratings.

Green Build 1 teaches students to consider factors affecting a home’s power consumption. To optimize their energy consumption, students will learn to focus on building materials, thermostat settings, and overall efficiency of their HVAC appliances. They will construct houses by choosing the size, window density, and wall and insulation materials. Next, they will configure appliances inside the house, balancing the initial cost of each appliance against its long-term energy efficiency.

Contents of this lesson plan

1. Teacher Preparation	
2. Part 1	EXPLORE (directed inquiry)
3. Part 2	REFLECT (group discussion)
4. Part 3	ACCOMPLISH (the assigned task)
5. Part 4	CONNECT (to standards and the real world)
6. Student Worksheets	
7. Standards Met	

Students will learn that the primary sources of energy are electricity and natural gas, and that the bulk of the energy used in a house goes toward heating, cooling, ventilation, and water heating (HVAC). They will see that there is a broad range of appliance types with widely differing efficiencies, technologies, and costs. The overall goal of the simulation is to construct and configure a house that runs efficiently, and under budget, for one year.





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TEACHER PREPARATION

Review this prior to class!

Instructional Approach

This lesson plan uses directed inquiry to lead students to discover the questions they should ask about a topic, and the answers to those questions.

Teacher's Role

The teacher's role is classroom facilitator and expert consultant. You will lead students to explore and help them when they have problems. Many students will learn much more than is formally included in this lesson plan, and they will also be able to help other students.

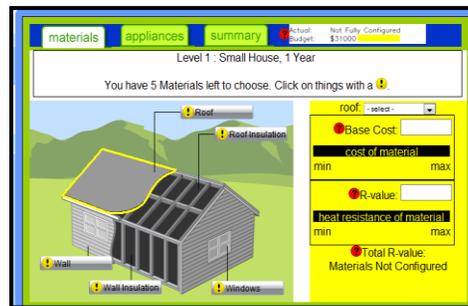
Materials

1. Computers with Internet access and confirmed access to Whyville
2. CONNECT worksheet, included in this lesson plan.
3. Calculator (optional).

These instructions are for the teacher only! They help you quickly learn about the Whyville content and see how the lessons are learned by the students. When class time arrives, follow the instructions in **PART 1 -- EXPLORE**, and let the students explore the content and discover the lessons on their own.

Follow these instructions to prepare to facilitate for your class.

1. Log into Whyville and select *WhyPower* from the Bus menu (see picture →).
2. Click the link *WhyPower Station*.
3. Click the link *Green Build*, and then click the button *1 Year* for the smaller house. You will arrive at the screen shown below.
4. Choose materials for the roof, roof insulation, wall, wall insulation and windows.
5. Click on the *Appliances* tab and select your appliances.
6. Click on the *Summary* tab to see how you fared on staying within budget. Go back and change settings if you are over budget.
7. Repeat these steps for the larger house, for *1 Year*.

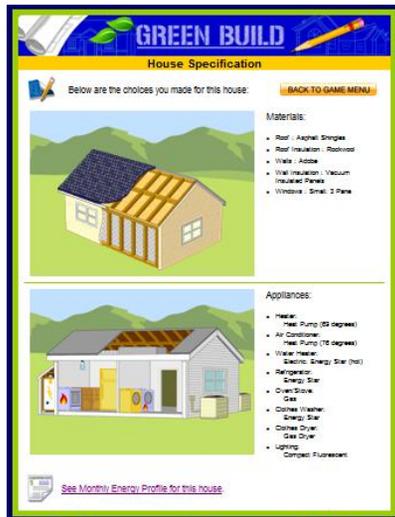




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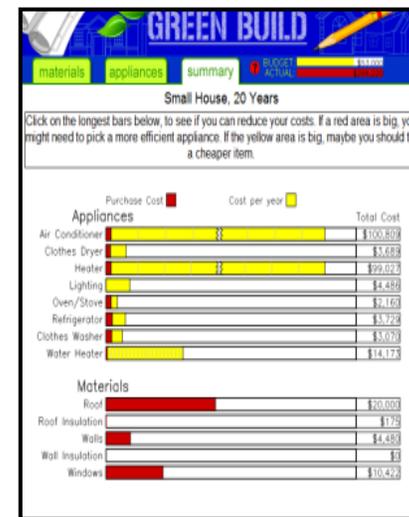
TEACHER PREPARATION Review this prior to class!

- Click on the Summary tab to see how you fared on staying within budget. Go back and change settings if you are over budget.
- When you are within the budget, click done, and examine your house specifications and the monthly energy profile.



GREEN BUILD
Monthly Energy Profile

Appliance	Item	Power/Month	Cost/Month
Heater	Heat Pump (69 degrees)	162.29 kW-H	\$ 21.10
Air Conditioner	Heat Pump (76 degrees)	206.56 kW-H	\$ 26.85
Water Heater	Electric Energy Star (hot)	353.85 kW-H	\$ 46.00
Refrigerator	Energy Star	63.62 kW-H	\$ 8.27
Oven/Stove	Gas	333 kBtu	\$ 4.00
Clothes Washer	Energy Star	60.92 kW-H	\$ 7.92
Clothes Dryer	Gas Dryer	667 kBtu	\$ 8.00
Lighting	Compact Fluorescent	13.85 kW-H	\$ 1.80
Total energy used per month:		861.08 kW-H 999 kBtu	
Total energy cost per month:			\$ 123.94



Note the differences in Materials costs and the impact different materials make to the R-Value (thermal resistance) of the house.

Go to <http://www.energystar.gov/> to familiarize yourself with information about Energy Star so you can direct students to this site if they ask what Energy Star is.



ENERGY MEASUREMENTS

The most relevant measures of energy are kilowatts, kilowatt-hours and BTUs. These measures can be difficult to understand because the kilowatt is actually a rate of energy usage, even though that’s not obvious from the name. Kilowatts are like miles per hour (mph). Miles per hour indicate how fast a car is going at a moment in time. Similarly, kilowatts indicate how much energy per second is being used at a moment in time. Kilowatt-hours indicate how much total energy is used, just like “miles” indicates total distance traveled. The interesting thing to understand about kilowatt-hours is that it measures energy use over any time period, not just over one hour!

Term	Definition	Is this a Rate of use, or Total use?	It’s analogous to ...
Kilowatts	The rate of usage of energy in some process (like running an A/C unit)	Rate of use	Miles per hour
Kilowatt-hours	Total energy use over some amount of time	Total use	Total miles traveled

BTU stands for British Thermal Units. BTU is a total energy measurement, like kilowatt-hours (and miles). By tradition, it is used in measuring energy produced with propane and natural gas.

Term	Definition	Is this a Rate of use, or Total use?	It’s analogous to ...
BTU	Total energy use over some amount of time. Equivalent to ~ 4,000 kilowatt-hours.	Total use	Total miles traveled

You will see these units of energy measure on the Monthly Energy Profile.





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TEACHER PREPARATION
Review this prior to class!

R-VALUE

The R-value is the thermal resistance of an object, or more specifically, the ratio of the temperature difference across an insulating material and the heat flow per unit area. This is a measure of how easily the object will transfer heat energy. The higher the R-value, the greater the insulating effectiveness. The R-value of insulation depends on the type of material, its thickness, and density. Insulation must be properly installed to derive the full insulation benefit.

MATH

Students will exercise graph interpretation skills, since the graph at the top tracks budget as the students select materials and appliances. In addition, students may exercise estimation skills as they make educated selections about which materials and appliances they can afford, and which materials and appliances to change should they be over budget. Also, students may exercise mental arithmetic skills to help them determine in advance the change in budget should they make a selection, and as they determine in advance new materials and appliances to select should they be over budget.



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PART 1 – EXPLORE

Do this for the first 20 minutes of class

Starter Question 3 minutes

What makes a green home green? What would you change on an old house to make it greener?

Perform these *Teacher Actions*

Do these in the order indicated

Expect this *Student Experience*

You should see your students experience the following

1. ENGAGE (3 minutes)

Ask students the Starter Question. Facilitate a class discussion for three minutes and help the students take ownership of the lesson.

ENGAGEMENT

Students take ownership while they are discussing a question that matters to them.

2. DIRECT (2 minutes)

Direct students to log into Whyville, go to *WhyPower*, and then to *WhyPower Station*, and then to *Green Build*. Direct them to explore the activities inside Green Build.

NOTE: Avoid giving further directions. Let them explore individually in teams and figure out for themselves what is going on, and how to be successful in the activities.

EXPLORATION

Within five minutes of the start of the lesson, students are logged into Whyville and in the Green Build area, exploring the simulation, learning what is important and how to be successful.

3. COACH (15 minutes)

Wander around the room, encourage students to help each other, and help individual students if they cannot work through problems. Ask students what is important to succeed in the activity, and assist them where they have additional questions.





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PART 1 – EXPLORE

Do this for the first 20 minutes of class

WHERE DO THE LESSONS APPEAR? Recognize the Core Content

Roof: Glass

Base Cost: \$20000

cost of material

R-value: 0.91

efficiency of insulation

Total R-value: 2.99

Oven/Stove: Gas

Base Cost: \$960

retail cost of appliances

Energy Usage: 333333 BTU

Monthly Cost: \$4

cost to run per month

Lighting

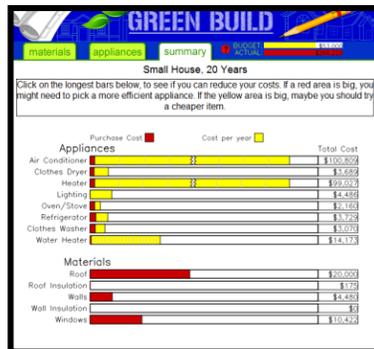
Base Cost: \$15

Energy: beeswax

Yearly Cost: \$3000

Click to edit

Appliance	Item	Pover-/Month	Cost/Month
Heater	Heat Pump (69 degrees)	162.29 kW-H	\$ 21.10
Air Conditioner	Heat Pump (76 degrees)	206.56 kW-H	\$ 26.85
Water Heater	Electric: Energy Star (hot)	353.85 kW-H	\$ 46.00
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Total energy used per month:		861.08 kW-H 999 kBTU	\$ 123.94



On the materials selection page is the R-Value of the material and total R-Value of the building once all materials have been selected.

Appliance base cost is on the appliance selection tool. The Summary Tab provides information on the appliance purchase cost and on the operational cost. Hovering over any line on the Summary Page will display a pop-up box which shows the yearly cost, and a link to edit that selection.

A **Done** button will appear to display the Energy Profile. It is only available once the building and appliances have been selected and are within the budget.



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PART 2 – REFLECT

Do this for the next 10 minutes of class

	Perform these <i>Teacher Actions</i> <i>Do these in the order indicated</i>	Expect this <i>Student Experience</i> <i>You should see your students experience the following</i>
1.	<u>GATHER</u> Give students a warning that exploration time is almost over. After a minute has passed, have the students direct their attention towards you.	<u>GATHERING</u> Students wrap-up their self-guided exploration and turn their full attention to the discussion.
2.	<u>FACILITATE</u> Lead students to discuss the questions below. Resist any urge to give them the answers.	<u>REFLECTING (group)</u> Students share their ideas and refine their ideas in large group discussion.

Questions

	Question	Expected Answer
1.	What is Green Build about? What things should I consider when building a green home?	Creating homes that are “green” – homes that use energy efficiently. Budget, cost of appliances and materials, cost of operation of appliances over time.
2.	What do you need to do to succeed?	Building green homes that stay under budget; earning technical and/or professional badges.
3.	What do you need to know to succeed?	What R values are; what kilowatt-hours are; how to add them up
4.	What questions do you still have?	
5.	Beyond your grade, do you care about this? Does this topic affect your life?	
6.	Name a real world job that is like this job.	Home Energy Technician





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PART 3 – ACCOMPLISH

Do this for the next 15 minutes of class

	Perform these <i>Teacher Actions</i> <i>Do these in the order indicated</i>	Expect this <i>Student Experience</i> <i>You should see your students experience the following</i>
1.	<u>DIRECT</u> Tell the students that their goal is to earn their Home Energy Technician career badges. Direct them to Green Build to either earn the badge or show you that they already earned the Home Energy Technician badge. NOTE: Many will have earned the badges during the EXPLORE section.	<u>ACCOMPLISHING</u> Students work independently to earn their badges. Those that already earned their badge help those who have not. They receive help from the teacher as needed.
2.	<i>Transition to</i> <u>CONNECT</u> As students achieve their accomplishment, and are done assisting their classmates, direct them to complete the worksheet from the CONNECT section.	





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PART 4 – CONNECT
Five Minute Student Analysis

Name and Date		
Class Period and Whyville ID		
1. What was this lesson about?		
2. What did you need to know to succeed?		
3. What new questions did you think of?		
4. What is a kilowatt-hour?		
5. What is an R-value?		
6. Name a real world career that is related to what you learned today.		
7. Do you care about what you learned? Is it relevant to your life? Why or why not?		





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EXTRA CREDIT WORKSHEET

Name and Date		
Class Period and Whyville ID		
What percentage of your total budget is made by the initial cost of your appliances?	Small House:	Large House:
What percentage of your total budget is spent on operating your appliances over the course of the year?	Small House:	Large House:
What percentage of your budget is spent on the building materials?	Small House:	Large House:
Did homes with low kilowatt-hours have high or low energy bills?		
Do you want a high or low R-value on your home? What did you observe that led you to this conclusion?		
After selecting your appliances, note the R-value and the total energy cost per month. Go back and change your building materials so that your R-value changes, but make sure your appliances stay the same. Notice how the R-value affected the energy bill. How does the choice with the higher R-value affect the energy bill each month?		





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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
8th Grade

All standards listed are impacted by this lesson plan. **Boldfaced** standards represent the focus of the lesson plan.

TEKS: Career Investigation

- (2) The student knows how to locate, analyze, and apply career information. The student is expected to:
 - (A) access career information using print and on-line resources to complete an educational and/or training plan for a career pathway;
 - (C) complete career critiques gained through a variety of experiences (for example, shadowing, career study tours, guest speakers, career fairs, videos, CD-ROM, Internet, and simulated work activities); and
- (3) The student knows that many skills are common to a variety of careers and that these skills can be transferred from one career opportunity to another. The student is expected to:
 - (A) compile a list of multiple career options matching interests and aptitudes; and
 - (E) role-play appropriate interviewing techniques for an employment opportunity in the student's interest area.
- (6) The student knows the process of career planning. The student is expected to:
 - (A) list and explain the steps in the decision-making process;
- (8) The student knows the effect change has on society and career opportunities. The student is expected to:
 - (A) cite examples of change in our society;
 - (B) compose a report explaining positive and negative aspects of one of the examples of societal change;

TEKS: Exploring Careers

- 1) The student explores personal interests and aptitudes as they relate to education and career planning. The student is expected to:
 - (D) research current and emerging fields related to personal interest areas;
 - (G) research educational options and requirements using appropriate technology.
- 2) The student analyzes personal interests and aptitudes regarding education and career planning. The student is expected to:
 - (C) develop and analyze tables, charts, and graphs related to career interests;
 - (D) determine the impact of technology on careers of personal interest; and
 - (E) identify entrepreneurial opportunities within a field of personal interest.



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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
8th Grade

- (4) The student evaluates skills for personal success. The student is expected to:
- (A) implement effective study skills for academic success;
 - (B) use interpersonal skills to facilitate effective teamwork;
 - (C) use a problem-solving model and critical-thinking skills to make informed decisions;**
 - (D) use effective time-management and goal-setting strategies;
 - (E) effectively use information and communication technology tools; and
 - (F) identify skills that can be transferable among a variety of careers.
- (5) The student recognizes the impact of career choice on personal lifestyle. The student is expected to:
- (A) prepare a personal budget reflecting the student's desired lifestyle;
 - (B) use appropriate resources to compare and contrast salaries and educational requirements of at least three careers in the student's interest area; and
- (6) The student demonstrates an understanding of personal financial management. The student is expected to:
- (A) compare the advantages and disadvantages of different types of banking services;
 - (B) simulate opening and maintaining different types of bank accounts;
 - (C) simulate different methods of withdrawals and deposits; and
 - (D) reconcile bank statements, including fees and services.
- (7) The student develops skills for professional success. The student is expected to:
- (A) demonstrate effective verbal, nonverbal, written, and electronic communication skills;
 - (B) evaluate the impact of positive and negative personal choices, including use of electronic communications such as social networking sites;
 - (C) model characteristics of effective leadership, teamwork, and conflict management;
 - (E) explore and model characteristics necessary for professional success such as work ethics, integrity, dedication, perseverance, and the ability to interact with a diverse population; and
 - (F) complete activities using project- and time-management techniques.
- (8) The student identifies and explores technical skills essential to careers in multiple occupations, including those that are high skill, high wage, or high demand. The student is expected to:
- (A) complete actual or virtual labs to simulate the technical skills required in various occupations; and**



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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
8th Grade

- (B) analyze the relationship between various occupations such as the relationship between interior design, architectural design, manufacturing, and construction on the industry of home building or the multiple occupations required for hospital administration.

TEKS: Career Portals

- (1) The student explores one or more career clusters of interest. The student is expected to:
- (A) identify the various career opportunities within one or more career clusters; and
 - (B) identify the pathways within one or more career clusters.
- (3) The student explores programs of study. The student is expected to:
- (A) compare levels of education for careers of personal interest;
 - (B) identify the academic and technical skills needed; and
- (5) The student understands personal financial management and recognizes the value of personal fiscal responsibility. The student is expected to:
- (A) compare and contrast different types of banking services;
 - (B) open and maintain different types of simulated bank accounts;
 - (C) practice different methods of withdrawing and depositing funds;
 - (E) compare and contrast forms of credit, including credit cards and debit cards;

TEKS: Mathematics

- (1) Number, operation, and quantitative reasoning. The student understands that different forms of numbers are appropriate for different situations. The student is expected to:
- (A) compare and order rational numbers in various forms including integers, percents, and positive and negative fractions and decimals;
 - (B) select and use appropriate forms of rational numbers to solve real life problems including those involving proportional relationships;



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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
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- (C) approximate (mentally and with calculators) the value of irrational numbers as they arise from problem situations (such as $\sqrt{2}$, $\sqrt{2}$);
- (E) compare and order real numbers with a calculator.
- (2) Number, operation, and quantitative reasoning. The student selects and uses appropriate operations to solve problems and justify solutions. The student is expected to:**
 - (A) select appropriate operations to solve problems involving rational numbers and justify the selections;
 - (B) use appropriate operations to solve problems involving rational numbers in problem situations;
 - (C) evaluate a solution for reasonableness; and
 - (D) use multiplication by a given constant factor (including unit rate) to represent and solve problems involving proportional relationships including conversions between measurement systems.
- (3) Patterns, relationships, and algebraic thinking. The student identifies proportional or non-proportional linear relationships in problem situations and solves problems. The student is expected to:**
 - (A) compare and contrast proportional and non-proportional linear relationships; and
 - (B) estimate and find solutions to application problems involving percents and other proportional relationships such as similarity and rates.
- (4) Patterns, relationships, and algebraic thinking. The student makes connections among various representations of a numerical relationship. The student is expected to generate a different representation of data given another representation of data (such as a table, graph, equation, or verbal description).
- (5) Patterns, relationships, and algebraic thinking. The student uses graphs, tables, and algebraic representations to make predictions and solve problems. The student is expected to:**
 - (A) predict, find, and justify solutions to application problems using appropriate tables, graphs, and algebraic equations; and
 - (B) find and evaluate an algebraic expression to determine any term in an arithmetic sequence (with a constant rate of change).
- (14) Underlying processes and mathematical tools. The student applies Grade 8 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to:**
 - (A) identify and apply mathematics to everyday experiences, to activities in and outside of school, with other disciplines, and with other mathematical topics;
 - (B) use a problem-solving model that incorporates understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness;



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- (C) select or develop an appropriate problem-solving strategy from a variety of different types, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem; and
 - (D) select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.
- (15) Underlying processes and mathematical tools. The student communicates about Grade 8 mathematics through informal and mathematical language, representations, and models. The student is expected to:
- (A) communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models; and
 - (B) evaluate the effectiveness of different representations to communicate ideas.
- (16) Underlying processes and mathematical tools. The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to:
- (A) make conjectures from patterns or sets of examples and nonexamples; and
 - (B) validate his/her conclusions using mathematical properties and relationships.

TEKS: Science

- (2) **Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and field investigations. The student is expected to:**
- (A) plan and implement comparative and descriptive investigations by making observations, asking well-defined questions, and using appropriate equipment and technology;
 - (B) design and implement comparative and experimental investigations by making observations, asking well-defined questions, formulating testable hypotheses, and using appropriate equipment and technology;
 - (C) collect and record data using the International System of Units (SI) and qualitative means such as labeled drawings, writing, and graphic organizers;
 - (D) construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and
 - (E) **analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.**



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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
8th Grade

- (3) Scientific investigation and reasoning. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions and knows the contributions of relevant scientists. The student is expected to:
 - (B) use models to represent aspects of the natural world such as an atom, a molecule, space, or a geologic feature;

Blooms (Taxonomy):

X	Knowledge: arrange, define, duplicate, label, list, memorize, name, order, recognize, relate, recall, repeat, reproduce state.
X	Comprehension: classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate
X	Application: apply, choose, demonstrate, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write.
X	Analysis: analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test.
X	Synthesis: arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
X	Evaluation: appraise, argue, assess, attach, choose compare, defend estimate, judge, predict, rate, core, select, support

Instructional Strategies:

X	Identifying similarities and differences
X	Summarizing and note taking
X	Reinforcing effort and providing recognition
	Homework and practice
X	Nonlinguistic representations
X	Cooperative learning
X	Setting objectives and providing feedback
X	Generating and testing hypotheses
X	Cues, questions, and advanced organizers





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STANDARDS MET
Common Core Math, Grades 6 to 8

All standards listed are impacted by this lesson plan. **Boldfaced** standards represent the focus of the lesson plan.

Sixth Grade

<i>Subcategory</i>	<i>Standard ID</i>	<i>Standard Description</i>
Expressions and Equations	6.EE.6	Use variables to represent numbers and write expressions when solving a real world or mathematical problem; understand that a variable can represent an unknown number, or, depending on the purpose at hand, any number in a specified set.
Expressions and Equations	6.EE.7	Solve real world and mathematical problems by writing and solving equations of the form $x + p = q$ and $px = q$ for cases in which p, q and x are all nonnegative rational numbers.

Seventh Grade

<i>Subcategory</i>	<i>Standard ID</i>	<i>Standard Description</i>
Expressions and Equations	7.EE.4.A	Use variables to represent quantities in a real world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. a. Solve word problems leading to equations of the form $px + q = r$ and $p(x + q) = r$, where p, q, and r are specific rational numbers. Solve equations of these forms fluently. Compare an algebraic solution to an arithmetic solution, identifying the sequence of the operations used in each approach. For example, the perimeter of a rectangle is 54 cm. Its length is 6 cm. What is its width?



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STANDARDS MET
Common Core Math, Grades 6 to 8

<i>Subcategory</i>	<i>Standard ID</i>	<i>Standard Description</i>
Expressions and Equations	7.EE.4.B	Use variables to represent quantities in a real world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. b. Solve word problems leading to inequalities of the form $px + q > r$ or $px + q < r$, where p , q , and r are specific rational numbers. Graph the solution set of the inequality and interpret it in the context of the problem. For example: As a salesperson, you are paid \$50 per week plus \$3 per sale. This week you want your pay to be at least \$100. Write an inequality for the number of sales you need to make, and describe the solutions.