



ELECTRIC FARM 1

in Whyville

CAREER FOCUS

Electric Farm Technician
Electric Farm Engineer
Progress toward Power Planner Technician

ACADEMIC FOCUS

Understanding the placement of energy collection devices to maximize wind and solar energy collection; measuring electrical energy; understanding rate of earning on investment.

Electric Farm 1 begins an exploration of green energy generation. Students will need to purchase solar panels and/or wind turbines and place them in various Whyville locations. These collectors generate power if placed in appropriate environmental conditions. The power can then be sold back to the power grid, hopefully making more clams than the students paid to purchase the collectors. Our career focus will look at the role of an *Electric Farm Technician*, who understands the use of one type of green energy production, and at the *Electric Farm Engineer*, who can successfully place both solar panels and wind turbines. Finally, we will reinforce the lessons about energy learned in earlier lessons.

Contents of this lesson plan

1. Teacher Preparation	
2. Part One	EXPLORE (directed inquiry)
3. Part Two	REFLECT (group discussion)
4. Part Three	ACCOMPLISH (the assigned task)
5. Part Four	CONNECT (to standards and real life)
6. Standards covered	





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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 optimal placement of solar panels and wind turbines, the amount of power each collector is capable of, and the answers to those questions.

Teacher's Role

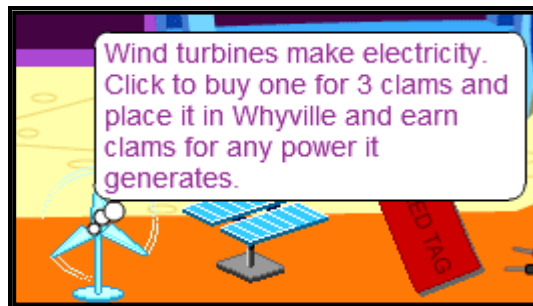
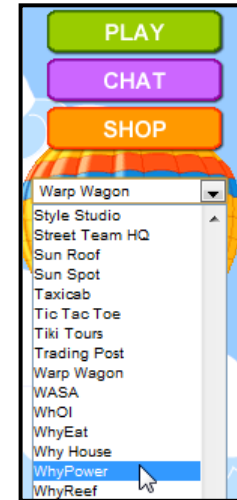
The teacher's role is classroom facilitator and expert consultant. You will lead students to explore and help them when they get in trouble. Many students will learn much more than is formally included in this lesson plan, and will also be able to help other students.

Materials

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

Follow these instructions in preparation for the classroom lesson.

1. Log into Whyville and select *WhyPower* from the Bus menu (see picture →).
2. Click the link *WhyPower Station*.
3. Hover your mouse over the Wind Turbine and read the directions.



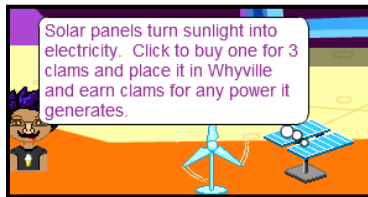
4. Click on the Wind Turbine.



5. Buy a Wind Turbine by saying "pretty please".



6. Put your mouse over the Solar Panel and read the directions.



7. Click on the Solar Panel.



8. Buy a Solar Panel by saying "pretty please".

9. Click on the Lightning Bolt Placard on Becky's desk to get suggestions about where to place your collectors.



Some places you can go are:

- Meadow
- Playground
- WhyPower Outside
- Beaches
- Bioplex
- Sportplatz



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TEACHER PREPARATION

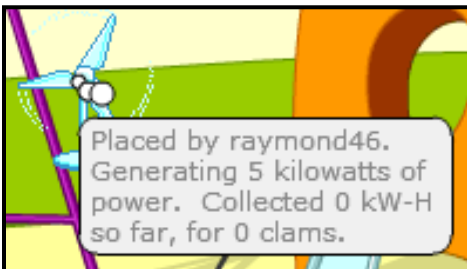
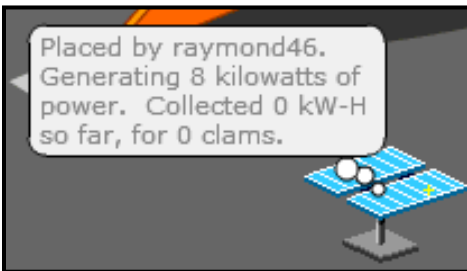
Review this prior to class!

10. Transport to that room. Place a wind or solar collector in the room by saying "whypower solar" or "whypower wind."

Yay! Your solar panel will be collecting energy over the next hour. Check back to see how it's doing.

Yay! Your wind turbine will be collecting energy over the next hour. Check back to see how it's doing.

11. Mouse over the collector after it's been in place for a while to see how much energy it is producing. (The collector will stay in a room for an hour.)



12. You'll be able to see how successful you've been in placing your purchased energy collectors by examining your checking account statement at the bank. Go to the Bank Account icon at the top of the window and view your Checking Statement.



58,073.0 clams

Mar 12 10:16 AM	WhyPower Solar Collector	2
Mar 12 10:15 AM	WhyPower Solar Collector	1
Mar 12 10:14 AM	WhyPower Solar Collector	2
Mar 12 10:14 AM	WhyPower Wind Turbine Collector	5
Mar 12 10:14 AM	WhyPower Solar Collector	2
Mar 12 10:13 AM	WhyPower Wind Turbine Collector	5
Mar 12 10:13 AM	WhyPower Solar Collector	2



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TEACHER PREPARATION Review this prior to class!

MATH AND SCIENCE

Prior Lesson Refresher: Energy Measurements

The most practical measures of energy for this Adventure are **kilowatts**, and **kilowatt-hours** . 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). MPH indicates how fast a car is going at moment in time; 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 weird thing to understand about kilowatt-hours is that it is measures energy use over *any time period*, not 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

Power Generation

Wind Turbines take the mechanical energy of the wind rotating the turbine's blades to drive an electric generator. The generator converts mechanical energy to electrical energy. It is the opposite of an electrical motor where electrical energy is converted to mechanical energy.

Solar collectors generate electrical power through a chemical reaction in the presence of sunlight. There are a variety of different solar collectors. The solar collectors for this activity are photovoltaic cells that convert photons to electrons.

There are other types of solar energy generation besides PhotoVoltaic cells. There is a residential type of solar collector which is used as a water heater. Solar thermal energy plants use solar energy to produce steam, which drives a turbine to produce energy.





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TEACHER PREPARATION

Review this prior to class!

MATH

Students will be asked to calculate earnings on their investment in solar and wind collectors, and the rate of return on their investment. To calculate their earnings, they will need to look at their checking account to obtain the total amount paid for collectors (Cost) and the total amount of income earned in generating energy from their collectors. Remind them that their salary should not be a part of this calculation! Students will subtract the total cost from their total income:

$$\text{Earnings} = \text{Income} - \text{Cost}$$

The rate of return on investment is determined by dividing the earnings by the cost of the investment in energy collectors.

$$\text{Rate} = (\text{Income} - \text{Cost}) / \text{Cost}$$
$$\text{RatePercentage} = \text{Rate} * 100$$

Students can compare that rate of return to the percentage they get from putting money in a savings account at the bank, or into a CD.

Students should be asked to compare the rate of return on solar collectors with the rate of return on wind turbines. Whyville pays a clam per kilowatt hour for energy irrespective of the source. Collectors will generate power based on their environmental conditions.



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TEACHER PREPARATION
Review this prior to class!

CAREERS

Jobs in Wind Energy

There are Wind Farms springing up across the country in any location with a sustained wind and some available land. Commercial wind turbines are several stories high and are complicated to build, transport, install and maintain. Wind Farms require technicians on site to maintain equipment. For many regions, reports indicate that there is an insufficient amount of skilled workers to fill the demand created by these farms. In addition to large scale installations of wind farms, there are a small but growing number of homes and businesses that have installed their own wind turbine systems. There are only a limited number of companies that currently handle this sort of installation.

Jobs in Solar Energy

There are a limited number of Solar Electric Farms being built. The farms require a large relatively flat area and many days of sunshine. New installations require technicians to build the facility. Afterwards, fewer technicians are required to maintain the facility. Most growth in job availability is for businesses and homeowners installing roof-top solar panels to save energy. Some of this growth has been spurred on by tax credits, rebates, and other incentives offered by energy companies.



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PART 1 – EXPLORE

Do this for the first 20 minutes of class

Starter Questions 3 minutes

If you had small solar cells or wind turbines that collected energy, where would you put them?

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 the wind and solar collectors. Point out this is an opportunity to make clams if they can make some good choices.

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.

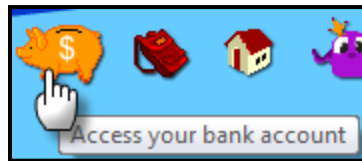
EXPLORATION

Within three minutes of the start of the lesson, students are logged into Whyville and in the energy collection activity, exploring the placement of wind and solar collectors to effectively collect energy and make clams.

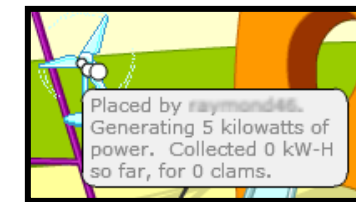
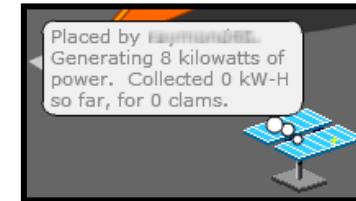
3. COACH (15 minutes)

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

WHERE DO THE LESSONS APPEAR? Recognize where the core content shows up.



Date	Transaction	Amount
Sep 4 12:49 PM	WhyPower Power Collector	4
Sep 4 12:49 PM	WhyPower Power Collector	4
Sep 4 12:49 PM	WhyPower Solar Collector	13
Sep 4 10:45 AM	WhyPower Power Collector	-3
Sep 4 10:44 AM	WhyPower Power Collector	-3
Sep 4 10:44 AM	WhyPower Power Collector	-3



Go to WhyPower Station

Go to the checking statement which can be found in your bank account, and then see **Statement** for the checking account.

The collectors report power and clams generated.



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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 one-minute warning that exploration time is almost over. Then, have the students turn off their screens quickly.	<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 are energy collector activities about?	Understanding that there is a cost to make energy and that the placement of the collectors is important to making clams for energy production.
2.	How do you achieve success in this activity?	Making more clams in energy production than it cost to buy the energy collectors.
3.	What is the difference between investing in energy collection and putting funds in a bank?	The bank is a safe investment. The rate of return is known and guaranteed. There's a risk with energy investment and the potential for losing the entire investment.
4.	What questions do you still have?	
5.	Beyond grades, do you care about this? Does or will green energy generation affect your life?	
6.	Can you think of any real world jobs	Wind Turbine Technician. Wind Power Technician/Field engineer



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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 today is to determine the state of their investments and determine what the best investment is. They will also identify the differences between investing in solar and wind collectors – both in power generation and return on investment. Students should go to their checking account statement to see how their investment in energy collectors turned out.	<u>ACCOMPLISHING</u> Students work independently to earn clams. Those that don't have a large pool of clams will need to be able to identify what they can do to be more successful in the future. Students who experienced success should be able to identify which collectors were most productive. They can 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		
How much have you spent, placing collectors around Whyville?		
How much have you earned on your investment?		
To earn clams which is more important: the type of collector, or the location? Why?		
What is your rate of return on your investment?		
Which (solar or wind) collectors generated more power per collector?		
How does the rate of return on energy investing compare with investments in the bank savings accounts and CDs?		
Identify a real world career that is related to what you learned today.		





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

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

TEKS: Career Investigation

- (1) The student analyzes the effect of personal interest and aptitudes upon educational and career planning. The student is expected to:
 - (B) match interests and aptitudes to career opportunities; 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
- (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;
 - (C) develop a timeline covering the last ten years depicting the change in a selected career choice,

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;
- (4) The student evaluates skills for personal success. The student is expected to:
 - (C) use a problem-solving model and critical-thinking skills to make informed decisions;
 - (F) identify skills that can be transferable among a variety of careers.
- (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.



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

- (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**
 - (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.**
- (2) The student explores pathways of interest within one or more career clusters. The student is expected to:**
 - (A) investigate career opportunities within the pathways;**
 - (B) explore careers of personal interest;**
- (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;**
 - (D) reconcile bank statements, including fees and services;**

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)
8th Grade

- (C) approximate (mentally and with calculators) the value of irrational numbers as they arise from problem situations (such as $\sqrt{2}$);
- (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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STANDARDS MET
Texas Essential Knowledge and Skills (TEKS)
8th Grade

- (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;
 - (E) analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends.
- (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:



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

- (A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
- (7) Earth and space. The student knows the effects resulting from cyclical movements of the Sun, Earth, and Moon. The student is expected to:
 - (A) model and illustrate how the tilted Earth rotates on its axis, causing day and night, and revolves around the Sun causing changes in seasons;
 - (B) demonstrate and predict the sequence of events in the lunar cycle; and
 - (C) relate the position of the Moon and Sun to their effect on ocean tides.

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,





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STANDARDS MET

Texas Essential Knowledge and Skills (TEKS)
8th Grade

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



ELECTRIC FARM 1 in Whyville

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

Subcategory	Standard ID	Standard Description
The Number System	6.NS.3	Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.
The Number System	6.NS.5	Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real world contexts, explaining the meaning of 0 in each situation.
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

Subcategory	Standard ID	Standard Description
Ratios and Proportions	7.RP.3	Use proportional relationships to solve multistep ratio and percent problems. Examples: simple interest, tax, markups and markdowns, gratuities and commissions, fees, percent increase and decrease, percent error.



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STANDARDS MET Common Core Math, Grades 6 to 8

Subcategory	Standard ID	Standard Description
Expressions and Equations	7.EE.2	Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related. For example, $a + 0.05a = 1.05a$ means that “increase by 5%” is the same as “multiply by 1.05.”
Expressions and Equations	7.EE.3	Solve multi-step real life and mathematical problems posed with positive and negative rational numbers in any form (whole numbers, fractions, and decimals), using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. For example: If a woman making \$25 an hour gets a 10% raise, she will make an additional 1/10 of her salary an hour, or \$2.50, for a new salary of \$27.50. If you want to place a towel bar 9 3/4 inches long in the center of a door that is 27 1/2 inches wide, you will need to place the bar about 9 inches from each edge; this estimate can be used as a check on the exact computation.

Eighth Grade

Subcategory	Standard ID	Standard Description
Expressions and Equations	8.EE.7.B	Solve linear equations in one variable. b. Solve linear equations with rational number coefficients, including equations whose solutions require expanding expressions using the distributive property and collecting like terms.