- Some of the vocabulary associated with functions and relations are often confused in that domain and range, independent variable and dependent variable, and functions and relations are often mistaken for each other. Encourage students to make sense of these terms by using words, images, graphic organizers and various forms of media to define and explain each term. Have students work together to make a poster collage for each term and hang them around the classroom so that students can use them as a reference.
- Some students have difficulty understanding the concept of mapping and how to create a mapping diagram. Have students explore mapping values that have very clear connections, like the relation between different musical notes and the number of beats each note contains (for example, a whole note is four beats, while a quarter note is one beat). Extend the musical analogy by including explanations of the domain, the range, the independent variable and the dependent variable.
- Have students explore the graphs of functions at **www.shodor.org/interactivate/activities/VerticalLineTest**. "Possible or Not" shows students the graph of a function for a real-life situation and has them determine whether or not the graph makes sense. "Vertical Line Test" gives students five points and has them attempt to make a function by connecting the points.

Using a Calculator

Explore functions by using a graphing calculator to create a function table. Simply enter the function and the domain values to find the corresponding range values.

1. Enter the function. Press the (Y=) to begin doing this. Be sure to clear any old equations.
2. Format the table. By going to the (TBLSET) menu, you can adjust the settings so that you can enter the independent variable.
3. Enter the domain values. Access the table by pressing the (TABLE) key. After entering each domain value, the range value should appear as it is calculated.

Create function tables for different functions and domain values. You can even use the (GRAPH) key to see how each appears on the coordinate plane.

Different calculators often require different keys or key strokes to perform an operation. Sometimes the primary function of a key on one calculator appears as the secondary function of a key on another calculator. Encourage students to practice performing different operations on their calculators. Getting to know how their own calculator works is an important part of being a savvy algebra student.

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Suggested Internet Resources

Periodically, Internet Resources are updated on our web site at www.LibraryVideo.com.

- **www.uwstout.edu/soe/profdev/middlemath/three/act3c.html**
  This web site from the University of Wisconsin offers suggestions for creating an algebra module on functions and formulas that is correlated to NCTM standards.
- **www.shodor.org/interactivate/activities/LinearFunctMachine**
  The Shodor Education Foundation presents an online interactivity in which students explore input and output values of a function machine to determine the linear function the machine is using.
- **www.mathforum.org/library/drmath/sets/select/dm_domain_range.html**
  Dr. Math answers questions about domain and range in this "Ask Dr. Math" section of "The Math Forum," a Drexel University site that contains resources and activities to aid all math learners and instructors.

Suggested Print Resources

- Great Source Education Group. *Algebra to Go:A Mathematics Handbook*. Great Source Education Group, Wilmington, MA; 2000.
- Sobel, Max A. and Evan M. Maletsky. *Teaching Mathematics:A Sourcebook of Aids, Activities, and Strategies (3rd Edition)*. Allyn & Bacon Publishers, Boston, MA; 1999.
- Tabak, John. *Algebra: Sets, Symbols, and the Language of Thought*. Facts On File, Incorporated, New York, NY; 2004.

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TEACHER'S GUIDE

Algebra for Students™

Functions & Relations

Grades 7-12

In algebra, students are challenged to make a leap, from the concrete world of numbers and real objects, to an abstract one of letters and symbols. *Algebra for Students* is designed to help students to become more comfortable in the abstract world of algebra through the exploration of problems in the real world, from using a system of linear equations to calculate the cost of a sushi roll to using a quadratic function to describe the path of a kicked football. Animated graphics, real-life locales and vibrant young hosts help to explain math concepts, highlight multiple ways of approaching a problem, illustrate common pitfalls to avoid and tackle some typical test questions.

This guide provides a program overview, background knowledge needed for understanding, vocabulary, discussion questions and activities, tips for using a calculator, as well as print and Internet resources to supplement the teaching of targeted algebra concepts.

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Program Overview

Mathematicians use charts, graphs, tables and mapping diagrams to illustrate relationships between data, like the relationship between the size of a beverage and its cost. A relation is a set of ordered pairs representing the two sets of data. The ordered pairs of a relation contain the first set of coordinates, known as the domain or independent variable, and the second set of coordinates, known as the range or dependent variable. A function is a relation in which each element of the domain is paired with exactly one element of the range. Function notation is used to define a function by an equation.

While all functions are relations, some relations are not functions. One way of determining whether or not a relation is a function is by using the vertical line test. If a vertical line passes through the graph of a relation at no more than one point, then the relation is a function. The designation of the domain and range is one factor that determines whether or not a relation is a function.

Many real-world situations are modeled using functions. Both the speed of an amusement park roller coaster over the course of a ride and the wait time for riding the roller coaster throughout the day can be represented by functions. Some games have a unique relationship between the level of the game and the number of points needed to reach the level. This can be represented by a step function. A step function remains constant in value over a given interval but changes in value from one interval to the next — like needing 1,000 points to advance from Level 1 to Level 2, then needing 2,000 points to advance from Level 2 to Level 3, and so on.

Background

Before studying the content discussed in the video, students should already be able to:

- Locate points within the Cartesian coordinate system.
- Plot points in the coordinate plane.
- Read and interpret data represented in charts, graphs, mapping diagrams and tables in order to extract appropriate information.

Vocabulary

function — A relation in which each element of the input is paired with exactly one element of the output according to a specified rule.

domain — The set of the first coordinates, or x-values, in the ordered pairs of a relation.

range — The set of the second coordinates, or y-values, in the ordered pairs of a relation.

independent variable — A variable that gives the input values of a relation. The values of the independent variable make up the domain of a relation.

(Continued)

dependent variable — A variable that gives the output values of a relation. The values of the dependent variable make up the range of a relation.

function notation — A way of naming a function that is defined by an equation. Using function notation, the equation $y = 4x + 9$ is written as $f(x) = 4x + 9$. The symbol $f(x)$ means "function of x" and is often read as "f of x" — it does not mean "f times x."

relation — A set of ordered pairs. In a relation, the first set of coordinates of the ordered pairs is the domain. The second set of coordinates is the range.

vertical line test — A method used to determine whether or not a relation is a function. If a vertical line passes through the graph of a relation at no more than one point, then the relation is a function.

step function — A function that remains constant in value over a given interval but changes in value from one interval to the next.

Pre-viewing Discussion

- Use a map to review graphing in the coordinate plane with students. Add the x-axis and y-axis to a map of your local community, then have students give the coordinates for various locations. Students can write their ordered pairs on the board and see if the rest of the class can identify the locations represented by each ordered pair.
- Show students a simple graph, like speed of a car during a trip to and from the store, and have them convert the information in the graph into a descriptive paragraph.
- Give students a simple set of data and have them make charts, graphs, mapping diagrams and tables that display that information in various ways.

Problems

1. Consider the relation expressed in the table:

Number of DVDs in Set	Price ($)
2	24
3	32
4	40
5	48

   (a) Determine the domain, range, dependent variable and independent variable.

   (b) Is this relation a function? Explain your answer.

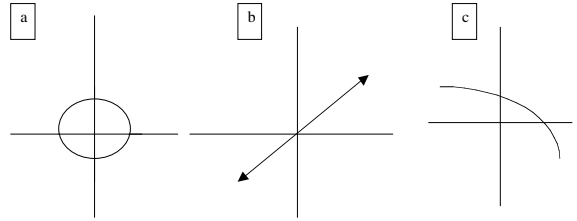
2. Determine whether or not the set of ordered pairs below represents a function.

   (6,-5) (-2,8) (6,7) (5,-4)

3. Explain how you would use the vertical line test to determine whether or not a graph represents a function.

(Continued)

4. Use the vertical line test to determine whether or not each of the graphs below represents a function.



Solutions

1. (a) The domain is {2, 3, 4, 5}.
   The range is {24, 32, 40, 48}.
   The dependent variable is the price in dollars.
   The independent variable is the number of DVDs in the set.

   (b) This relation is a function because each element of the domain is paired with exactly one element of the range.

2. This set of ordered pairs does NOT represent a function because one number in the domain — the number 6 — is paired with two numbers in the range: the numbers -5 and 7.

3. A graph represents a function if a vertical line passes through the graph at no more than one point. If you draw a vertical line on the graph and it passes through no more than one point, then the graph represents a function.

4. (a) This graph fails the vertical line test and does not represent a function.

   (b) This graph passes the vertical line test and represents a function.

   (c) This graph passes the vertical line test and represents a function.

Follow-up Discussion & Activities

- Algebraic relations exist in many aspects of everyday life. Have students research a relation (like the connection between the month of the year and the average amount of daylight) and organize the information into a chart, graph or table. They should also identify the domain, range, independent variable and dependent variable, and explain whether or not the relation is a function.
- Organize a field trip to a location that allows students to collect and analyze data that represents a relation or a function. For example, students could visit the local mall and collect data on how many people visit certain stores throughout the day. They can use the data to create charts, graphs and tables, and present their findings using the appropriate relation and function terminology.

(Continued)