

Guess my Rule

With Fathom

Teacher notes

- 1) Each student receives one of the 25 functions on a slip of paper.
- 2) Students make a *Fathom* file for the function by following these steps:
 - a. Circle all of the constants in the equation on the slip of paper.
 - b. Start *Fathom*.
 - c. Create a new graph by dragging the graph icon from the toolbar to the work area.
 - d. Create a slider for each of the constants in the given equation by dragging the slider icon from the toolbar to the work area. Keep dragging sliders on to the work area until you have one for each constant in the equation.
 - e. Click on the box in the upper right hand corner of your graph and pull the cursor down to “function plot.” An x and y axis should appear.
 - f. Make sure your graph is selected by clicking on it. Go to the graph menu and select “plot function.” Enter your function in the box which appears, putting letters in place of the constants in the equation. Make sure that each letter you use for constants have a corresponding slider with the same letter.
 - g. Set the slider for each constant to the value which is shown in the equation on the slip of paper.
 - h. Select the first slider by clicking on it. Go to the “display” menu and select “hide slider.” Repeat for as many sliders as you have on your screen.
 - i. Select the graph again by clicking on it. Go back to the “graph” menu and select “plot function.” Enter another equation which looks exactly like the first one, except use different letters for each of the constants.
 - j. Create sliders for each of the constants in your new equation. Once you have created new sliders, don’t hide them.
 - k. Save your file. If your function is labeled F1, save the file as F1.ftm. (i.e., save file Fx as Fx.ftm). Leave your work on the screen.
- 3) There are now 25 work stations in the classroom. Students can circulate from station to station and move the shown sliders until they have an equation which produces the same graph as that shown on the screen. Of course, one rule for the assignment is that students may not show the hidden sliders, since these give the answer away (this can be done by going to the “display” menu and selecting “show hidden objects”). Another rule is that they may not show anyone else the equation which is on the slip of paper they received. They can record their answers on the attached sheet. After recording the answers to each, they answer the reflection questions on the sheet as well. Their answers to these could form the basis for a class discussion.

Functions for "Guess My Rule" with *Fathom*.

$$F1: y = -\sin(3x)$$

$$F2: y = 5x + 3$$

$$F3: y = 2^x + 5$$

$$F4: y = -x^{-1}$$

$$F5: y = 3^{x-1}$$

$$F6: y = \cos(2x) - 5$$

$$F7: y = 3x^2 + 2x + 1$$

$$F8: y = 7x^3 + -12$$

$$F9: y = \cos(2x) + \sin(x)$$

$$F10: y = \sqrt{x} + 3$$

$$F11: y = 3(\tan(2x))$$

$$F12: y = \ln(x) + -4$$

$$F13: y = \frac{1}{3}|x| + 1$$

$$F14: y = x^2 + -2x + -3$$

$$F15: y = \sec(x - \pi)$$

$$F16: y = (x - 7)^3 + 2$$

$$F17: y = \ln(x) - 15$$

$$F18: y = 5^x + \pi$$

$$F19: y = 4|x - 7| + 3$$

$$F20: y = \frac{1}{4}\tan(x + 1)$$

$$F21: y = \sec(x) + \pi$$

$$F22: y = -\frac{1}{2}(x + \pi)^2$$

$$F23: y = \frac{1}{2}\cos(x) + 5$$

$$F24: y = 3e^x + 7$$

$$F25: y = x^4 - 6$$

Guess my Rule

Name _____

- 1) Make a *Fathom* file for the function you were given on the slip of paper by following these steps:
 - a. Circle all of the constants in the equation on the slip of paper.
 - b. Start *Fathom*.
 - c. Create a new graph by dragging the graph icon from the toolbar to the work area.
 - d. Create a slider for each of the constants in the given equation by dragging the slider icon from the toolbar to the work area. Keep dragging sliders on to the work area until you have one for each constant in the equation.
 - e. Click on the box in the upper right hand corner of your graph and pull the cursor down to “function plot.” An x and y axis should appear.
 - f. Make sure your graph is selected by clicking on it. Go to the graph menu and select “plot function.” Enter your function in the box which appears, putting letters in place of the constants in the equation. Make sure that each letter you use for constants have a corresponding slider with the same letter.
 - g. Set the slider for each constant to the value which is shown in the equation on the slip of paper.
 - h. Select the first slider by clicking on it. Go to the “display” menu and select “hide slider.” Repeat for as many sliders as you have on your screen.
 - i. Select the graph again by clicking on it. Go back to the “graph” menu and select “plot function.” Enter another equation which looks exactly like the first one, except use different letters for each of the constants.
 - j. Create sliders for each of the constants in your new equation. Once you have created new sliders, don’t hide them.
 - k. Save your file. If your function is labeled F1, save the file as F1.ftm. (i.e., save file Fx as Fx.ftm). Leave your work on the screen.

- 2) Circulate around to each of the other computers in the room. Use the sliders shown to figure out which function each person in class received. Record your answers in the appropriate spaces on the next sheet.

- 3) Answer the reflection questions on the next sheet. Be prepared to share your answers to each of these during class discussion.

Guess my Rule

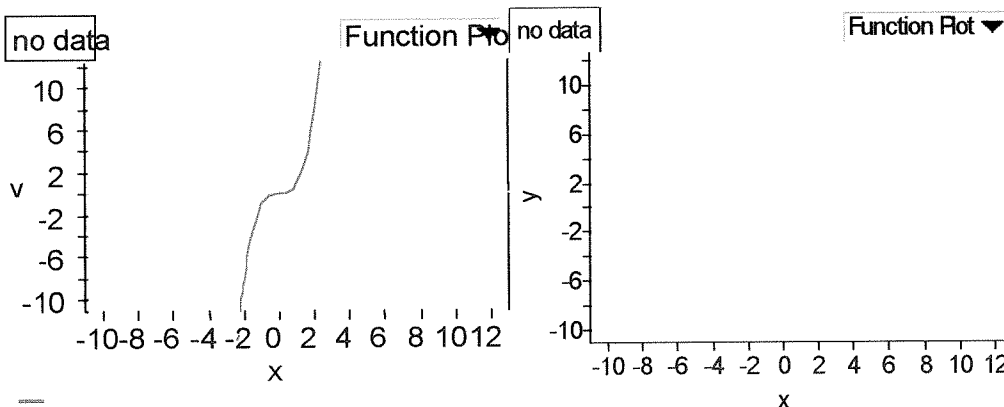
Name _____

Record what you think the equations are for each of the functions:

F1 _____	F10 _____	F19 _____
F2 _____	F11 _____	F20 _____
F3 _____	F12 _____	F21 _____
F4 _____	F13 _____	F22 _____
F5 _____	F14 _____	F23 _____
F6 _____	F15 _____	F24 _____
F7 _____	F16 _____	F25 _____
F8 _____	F17 _____	
F9 _____	F18 _____	

Reflection questions:

- 1) How does the graph of $f(x) + 5$ differ from the graph of $f(x)$? How does the graph of $f(x) - 5$ differ from $f(x)$? Why?
- 2) How does the graph of $f(x+5)$ differ from the graph of $f(x)$? How does the graph of $f(x-5)$ differ from the graph of $f(x)$? Why?
- 3) How does the graph of $5f(x)$ differ from the graph of $f(x)$? How does the graph of $-5(f(x))$ differ from the graph of $f(x)$? Why?
- 4) How does the graph of $\frac{1}{2}(f(x))$ differ from the graph of $f(x)$? Why? How does the graph of $-\frac{1}{2}(f(x))$ differ from the graph of $f(x)$? Why?
- 5) Below is a graph of $y = g(x)$. On the blank axes, sketch $\frac{1}{4}(g(x-2)) + -3$.



“Guess My Rule” and the NCTM Principles and Standards for School Mathematics

Activity Objectives

- Developing proficiency in using technology to analyze graphs of functions.
- Understanding how multiplying all of the outputs of a function by a constant changes the graph of the function.
- Understanding how adding a constant to all of the inputs of a function changes the graph of the function.
- Becoming familiar with the general shapes of exponential, linear, quadratic, cubic, quartic, and trigonometric functions.

Principles addressed (source: <http://standards.nctm.org/document/chapter2/index.htm>)

Teaching principle: “Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well.” *As students work through “Guess My Rule,” their responses to questions give the teacher an understanding of what they know about graphs of functions. Their responses to the activity can help inform future instructional plans.*

Learning Principle: “Students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge.” *Students use their background knowledge from Algebra and Geometry in order to perform the necessary tasks in “Guess My Rule.” The ability to work with a number of different functions gives them the opportunity to construct their own rules to describe the stretching, shifting, shrinking, and reflecting of functions.*

Assessment Principle: “Assessment should support the learning of important mathematics and furnish useful information to both teachers and students.” *“Guess My Rule” incorporates a number of important concepts from algebra and pre-calculus, as listed in the objectives section at the beginning of the paper. As such, student replies to the parts of the activity give the teacher a well-rounded picture of how much students understand about graphs of functions.*

Technology Principle: “Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning.” *In “Guess My Rule,” technology is used to help familiarize students with graphical behavior that may be cumbersome to explore manually.*

Alignment with Algebra Standard for Grades 9-12 (source: <http://standards.nctm.org/document/chapter7/alg.htm>)

- In the activity, students begin to “understand and perform transformations such as arithmetically combining, composing, and inverting commonly used functions, using technology to perform such operations on more-complicated symbolic expressions.”
- Students also begin to “understand and compare the properties of classes of functions, including exponential, polynomial, rational, logarithmic, and periodic functions.”

Alignment with Geometry Standard for Grades 9-12 (source: <http://standards.nctm.org/document/chapter7/geom.htm>)

- Students “investigate conjectures and solve problems involving two- and three-dimensional objects represented with Cartesian coordinates.”
- They also “use various representations to help understand the effects of simple transformations and their compositions.”
- Finally, throughout the activity, students “use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest.”