# In the Groove with Function Moves

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**Grade**: 7-8 or Algebra I

**Time Allotment**: Three 50-minute class periods

**Overview:** This lesson introduces students to the concept of functions expressed as tables and graphs. After creating and analyzing linear functions, students visit a web site where this skill is practiced in a game format. Graphing ordered pairs is a prerequisite skill.

**Subject Matter**: Mathematics, functions

**Learning Objectives:**
Students will be able to:

- Display data in a table of values, then graph.
- Develop an intuitive understanding of slope, y-intercept and the input/output characteristic of a function.
- Given a table of values and/or a graph determine its equation.
- Recognize that the coefficient of x controls the direction and steepness of the line.
- Recognize that the number added or subtracted is the value at which the function crosses the y-axis.

**Standards:**
This lesson addresses Va. SOL Mathematics 7.19, 8.14, A.5 available at
http://www.pen.k12.va.us

**Media Components**:
Video:
*X Power* # 5 "A Secret Code, Patterns"

Web sites:
http://www.bbc.co.uk/education/mathsfile/gameswheel.html This BBC Education web site's game, Planet Hop, provides practice in relating tables, graphs and equations.

**Materials:**
Materials needed for the Introductory Activity and Learning Activity:

- Large refrigerator box or washing machine box with holes large enough for students to walk or crawl through. On the outside of the box facing the class, post a blank t-table with cells the size of post-it notes.
- Five 8" by 11½" pieces of cardboard, each with a loop of string long enough to fit over a student's head. Write one input value on the front and its corresponding output value on the back of each piece of cardboard. A diagram is attached.

- Two packs of different colored post-it notes
- Computer with access to the Internet and large screen TV or projection device
- Overhead projector, blank overhead transparencies, transparency pens
- Transparency of a coordinate plane
- Transparencies of the following:
  - Student Worksheets 1, 2, and 3
  - Triangle Worksheet
  - Planet Hop Activity Sheet
- *Optional:* Fried Octopus Recipe
- *Optional:* an overhead TI- 83 graphing calculator and viewscreen. Equations can be entered in y= and then the table and graph features can be used for checking the equations.

For each student

- Student Worksheets 1, 2, and 3
- A sheet of waxed paper
- One 12-inch ruler
- 1 one-inch size (or larger) of "Laffy Taffy" candy. This can be purchased at a grocery store in the candy section.

For each pair of students

- A bag of 50 toothpicks
- Computer with access to the Internet
- Planet Hop Activity Sheet
- *Optional:* a TI- 83 or TI-83+ graphing calculator. Equations can be entered in "y=". The table and graph features can be used for checking the equations.

**Prep for Teachers:**

1. Prior to teaching this lesson, bookmark the site listed above. Visit the web site and familiarize yourself with the game Planet Hop.
2. Prepare the function box and input-output cards.
3. Make transparencies of the following:
   - Student Worksheets 1, 2, and 3
   - Triangle Worksheet
   - Planet Hop Activity Sheet
4. Make copies of the Student Worksheets 1, 2, and 3 for each student. Make one copy of the Planet Hop Activity Sheet for pair of students.
5. Cue the videotape to the beginning of the viewing segment. Familiarize yourself with the audio and visual cues used in the Culminating Activity portion of the lesson.

**Introductory Activity: Setting the Stage**

1. **Say:** "Today we will be learning about functions. Has anyone ever heard the word function used? (social function, church function, or school function) Today we are going to learn about what it means to be a mathematical function with our very own function machine."

2. **Say:** "Here we have a very powerful machine. When a number enters the machine, it undergoes an operation; it is transformed. Let's see how our function machine works."
3. **Say:** "I need five volunteers to take a trip through our function machine."
4. **Say to the volunteers:** "Each of you will be given a number to hang around your neck. Then, you will walk through the function machine. Be careful, you may experience some strange sensations." Out of the hearing range of the rest of the class, instruct the volunteers to enter the box, flip over the sign, make some noise or rattle the box, and then come out the opposite end.
5. Announce to the class that the first student is ready to experience the function machine.
6. **Say:** "Notice that this student is going into the function machine with the number -2. Let's record this on our table of values." Use a post-it note to post the input value in x-column of the table.
7. As the student comes out, ask the class what happened? (his/her number changed to 5) Record the new value in the y-column of the table. Repeat this with the other volunteers. Continue to announce the number going into the function machine, recognize the number that comes out and post the ordered pair in the table of values on the outside of the function machine.
8. **Say:** "Can anyone tell me what this machine is doing to these students' input values?" (Accept all answers.)
9. Hand out the Student Worksheets and **say:** "Record this data in the function machine table found on page three and then we will look at some other functions to see if that will help us figure out how this machine works."

**Learning Activities:**

1. **Say:** "Did you know that in Kyrgyzstan a favorite food is sheep's eyeballs? Let's suppose we are working for a local deli and want to create a table showing the relationship between the number of sheep and the number of eyeballs. If I have 0 sheep, how many eyeballs do I get? (0) If I have one sheep, how many eyeballs do I get?" (2)
2. Post the transparency of "Sheep Eyeballs, Anyone?" **Say:** "Let's see if we can complete the table of values. We will let the x column be the input or number of sheep and the y column will be the output or number of eyeballs. Can we extend this pattern?" (the number of eyeballs increases by two) "Can we develop an equation that tells us how many eyeballs we will have if we have x number of sheep?" (The number of eyeballs equals 2 times the number of sheep or $y = 2x$) "Will this equation always work?" (yes) "Why is it helpful to have an equation?" (Then we can extend the pattern for however many sheep we want.)
3. **Ask:** "Can we summarize by saying for each input or number of sheep, we get exactly one output or number of eyeballs?" (yes) "This is actually one definition of a function; for each input there is exactly one output. Can someone say the definition again for us?" (for each input there is exactly one output) Record the definition and have students write this in their notes.
4. **Say:** "Now let's see if we can graph this table of values." Graph the values on the coordinate plane provided.

5. **Say:** "Notice if the outputs in the y-column skip by 2's, this tells us that each input value, or x, will need to be multiplied by 2." (NOTE to teacher: for this introductory level we are concentrating on x values that always increase by 1.)
6. **Say:** "You have just created your first function and represented it as a table, equation, and graph."
7. **Post** the Octopus transparency. **Say:** "Let's look at another relationship and see if we can find its table, graph, and equation. This time we are going to grill octopus. Did you know this was a favorite appetizer of the Greeks?"
8. **Say:** "Think about how this table will look. When we start with one octopus, we end up with eight tentacles. So what does our input x, or independent variable represent? What does our output y, or dependent variable represent?" (The input is the number of octopus and output is the number of tentacles)
9. **Ask:** "Is this a function?" (yes) "Why?" (for each input of octopus there is exactly one output of octopus tentacles)
10. **Say:** "Please make a table of values and then graph it." Compare student answers to the answer key attached.
11. **Say:** "Notice in this example, the outputs in the y-column skip by 8. What does this tell us?" (Each input or x value will need to be multiplied by 8.)
12. **Say:** "What would the equation be for this function?" ($y = 8x$) "Knowing that $y = 8x$ is the equation, can you tell me how many tentacles we would have if we started with 100 octopuses?" (800) "Notice how you got this. You had to multiply 100, the input, by 8."
13. **Say:** "We have seen that when the outputs skip by a certain number, this is the number by which we will need to multiply our x's or inputs. Now we are going to look at a different situation. In this case, we want to see what happens to the number of segments as we add points. Find the line segment on your student worksheet." Model the process on the overhead. "If we have a line segment with two endpoints, we have the relation of two endpoints creating one segment. Therefore, what is the ordered pair?" (2,1)
14. **Ask:** "What does x represent? In other words what is our independent or control variable?" (the number of points) "What will y represent? In other words what is our dependent variable?" (the number of segments) "What does the t-table look like so far?" (2 points, 1 segment)
15. **Say:** "Place a point on the segment. How many segments do we have now?" (3 points, 2 segments) "Continue to add points to your segment and record the total number of points and the number of segments created." Check student work.
16. **Ask:** "Do you notice a pattern? Notice in this table our outputs in the y-column skip by 1's. What does this tell us?" (Each input will be multiplied by 1.) "But multiplying by one has no effect so we need to investigate further. What else could we do to make our inputs turn into our outputs?" (subtract one from each input) "Can you write an equation for this pattern?" ($y = x - 1$)
17. **Say:** "Now graph the ordered pairs and notice how this pattern is different from the previous ones." (We needed to use subtraction and the graph does not go through the origin but would cross the y-axis one unit below.)
18. **Ask:** "Is this still a function?" (yes, because for each input there is exactly one output.)

19. **Say:** “Now let’s build a function using triangles and toothpicks.” Have students work in pairs. Post the triangle worksheet on the overhead projector.
20. **Say:** “I am going to give each of you a bag of toothpicks and I want you to build the following patterns involving triangles. As you build, record the number of triangles and the number of toothpicks required.” Check student work.
21. **Say:** “As the number of triangles increases by one, what happens to the number of toothpicks?” (The number of toothpicks increases by 2.) Have students graph the function and compare its graph to those of the previous functions. Students should notice that the graph goes up from left to right, skips by 2,and crosses the y-axis at 1.
22. **Ask:** “How can we develop an equation for this function?” (If we notice how the outputs skip this will tell us that we need to multiply by 2. After we multiply the inputs by 2, we need to make any necessary adjustments by using addition or subtraction to make the outputs correct.)
23. **Ask:** “So what is the rule or equation?” (toothpicks = 2 times the number of triangles + 1 or $y= 2x + 1$)
24. **Ask:** “Is this a function?” (yes, because for each input there is exactly one output)
25. **Say**: “For our final exploration you will need a piece of Laffy Taffy, a ruler, and a sheet of waxed paper.” Hand out materials.
26. Draw a large S-shape on the overhead projector**. Say:** “Now I want you to roll your Laffy Taffy into a long ‘snake’ and place it on the waxed paper like the S-shaped diagram on the overhead.”
27. **Say:** “For this activity, we are going to make vertical cuts through the S shape and compare the number of vertical cuts and the resulting number of segments. Which will be the independent or control variable?” (the number of vertical cuts) “Which will be our dependent variable?” (the number of segments)
28. **Say:** “As we begin this, how many cuts do we have?” (0) “How many segments do we have?” (1) “So, what is our first ordered pair?” (0,1) “Let’s put this on a t-table.”
29. Post the table on the overhead.
30. **Say:** “Now take your ruler and press it through the Laffy Taffy. With one cut, how many segments do you now have?” (4) “What is the ordered pair?” (1,4)
31. **Say:** “Now continue to make cuts with your ruler and each time record the number of cuts and the number of segments in your t-table. Then, graph your results.”
32. **Say:** “Let’s compare your tables and graphs.” Post answer key on the overhead. Have students notice how the outputs are skipping. Remind students that this is the number by which the inputs must be multiplied.
33. **Ask:** “Is this a function and why?” (yes, for each input there is exactly one output) “Describe the graph.” (it goes up from left to right, it skips by 3 and it crosses the y-axis at 1)
34. **Say**: “ What would our equation be for this function?” ($y = 3x + 1$)

**Culminating Activity:**

**Part** I

1. **Provide a focus for media interaction** by saying: "Now we have a challenge to face. RJ and his friends have offended Caesar, the Emperor of Rome. They have a series of puzzles to solve or risk the wrath of Caesar."
2. **Say:** "Focus on the video and identify the puzzle the kids must solve." **Start** the video right after the green triangle patterns where you see the walls stop closing in on the kids and you hear Amanda say, " Each shape represents a square number."
3. **Pause** right after Caesar says, "…a pattern you have seen before, find it, and open up the door." Make sure the table of values is still visible.
4. **Ask:** "What is our challenge this time?" (to find the pattern in the table)
5. **Say:** "Work with a partner and see if you can figure out the equation for this new pattern. Think what rule takes each input and changes it into the output."
6. After a short period of student discussion**, say:** "What do you think the pattern is?" (Add three to the x values or $y = x + 3$)
7. **Say:** "Let's check and see if that's what the kids think." **Resume** and **pause** after Shauna says, "The number on the left will be $x + 3$." Check for comprehension.
8. **Fast-forward** until the spikes start receding into the ceiling and R.J. tilts his head back and says, "Whoa."
9. **Say:** "Before we see the next challenge, I want you to listen for the warning Caesar has for R.J. and his friends." **Resume** the video and **pause** after Caesar says, "Before you leave the problem behind gather all the clues you can."
10. **Ask:** " What was Caesar's warning?" (to gather clues)
11. **Ask:** "What kind of clues does a table give us?" Accept all answers.
12. **Say:** "Let's see what they do with this table of values." **Resume** and **pause** when the ordered pair (3,6) is plotted. **Ask:** "So what did they decide to do?" (graph the points)
13. **Say**: "Now I want you to listen for the six observations that can be made once the points are plotted."
14. **Resume** and **pause** after Amanda says, "Maybe that means we add 3."
15. **Say**: "What were the six observations that could be made?" Have students record these in their notes. (All points lined up. The line slanted upwards. A line could extend through the points. There were lots of other points they could have put on the table. The line crosses the y-axis at 3. That's the same as the constant 3 in our pattern x +3.) **Rewin**d and **replay** if necessary.
16. **Focus:** " Now get ready for table number two." **Resume** and **pause** when Marty says, "Ok, can we spot the pattern?" and the X-POWER logo appears.
17. **Say:** "Take a few minutes and see if you can find the equation for this table. Be sure to notice how the y's are skipping and where the line crosses the y-axis." ($y = 2x + 3$) Discuss guesses.
18. **Say:** " Let's see how we did." **Fast-forward** and **resume** right after the numbers are highlighted in orange and Matt appears. Make sure the class hears him say, "Multiply the number in the x column by 2 and add the 3 back in and it works."
19. **Pause** the video when the $2x + 3$ is entered in the table and you hear, "So our pattern is $2x + 3$." Check for comprehension.

20. **Say:** "Class, you are now ready to face the ultimate challenge. This table will be unlike any you have ever seen. It will be difficult. Be prepared to give your full attention to the next segment." **Resume** and **pause** when Amanda says, "…and it crosses the y-axis at 5."
21. **Say:** "This is your final function. Make sure you notice how the outputs or y's are skipping in this table." (down by 1's) "Also notice where the line crosses the y-axis." (at 5). "I will give you a few minutes to test your guesses." After several minutes **say,** "Do you have any idea what the equation will be?" (Accept all answers.)
22. **Say:** "Let's see how we did." **Resume** and **pause** after Marty says, "So that pattern is –1 times x plus 5." Check answers. **Rewind,** if necessary.
23. **Say:** "I want you to notice that R.J. expresses this function a little differently." **Resume** and **stop** when the expression 5 – x is displayed. Explain to students that this is really the same expression since it means 5 + (-x).
24. **Say:** "Now let's return to our function machine and see if we can crack its formula. Graph the ordered pairs and see if you can figure out the equation."
25. **Ask:** "What do you think the equation is?" (y = -2x +1) Congratulate those that figure out the equation. *Optional:* For prizes, hand out copies of the Fried Octopus Recipe.

**Culminating Activity**
**Part II**

1. Assign students a partner and have students move to the computers. Provide students with a **focus for media interaction** by saying: "You will now be visiting a web site where you and your partner will practice graphing points and finding the equation for various linear equations. You will have an activity sheet on which to record your game scores and observations."
2. Have students go to http://www.bbc.co.uk/education/mathsfile/gameswheel.html. Hand out activity sheets. (attached)
3. **Focus:** "Find the game, 'Planet Hop', located at the bottom of the game wheel, and double click on it. Notice there are three levels of difficulty. We will be working on level two today."
4. **Say:** "As you work on level two, I want you to notice how the y's are skipping and whether they are going up or down. This determines the slope or the value by which you will multiply x. Then notice where the line crosses the y-axis. This is called the y-intercept and is the constant that will be added or subtracted. If the line crosses above the origin, the value is added and if the line crosses below the origin, the value is subtracted. Once you and your partner receive a score of 6 out of 6, call me over and I will initial it. Just remember to continue working on level two until you have answered all of the questions and let me initial your score before moving on. You are welcome to check out the prizes if you win."

5. **Note:** Students completing level two may move on to level three which includes ordered pairs with fractional values or level one which explores horizontal and vertical lines.

**Cross-Curricular Extensions**

Mathematics:
http://www.madras.fife.sch.uk/maths/homelearning/S5courseH.html This web site provides multiple resources for further investigation of linear equations. Number 4 under the teaching resources is especially good.

Science:
http://www.noblenet.org/reference/crickets.htm Use this site to have students explore the functional relationship between the number of cricket chirps and the temperature.

Language Arts:
http://www.seattlecentral.org/qelp/Multi.html#A0108 Have students refer to discussions about data sets and analyze the usefulness of verbal descriptions of data. The discussion about the presence of lead and zinc in fish is particularly poignant.

Economics:
http://www.oanda.com/convert/classic Use this site to find monetary exchange rates. Have students use these to create t-tables, graphs and equations. Students can then see how much foreign currency it would take to purchase items advertised in the local newspaper.

**Community Connections:**

- Have an owner of a local taxi company visit the classroom and discuss taxi fares and how they are calculated.
- Have a caterer visit the classroom and discuss charges for catering services.
- Have a cell phone representative visit the classroom and discuss how monthly cell phone bills are calculated.
- Invite an appliance repairman or car mechanic to visit and explain how a repair bill has an hourly fee and a service charge.

**Student Materials**:
- Student Worksheets 1, 2, and 3
- Planet Hop Activity Sheet

**Additional Teacher Materials:**
- Triangle Worksheet
- Function Machine Cards
- Answer Keys for Student Worksheets 1, 2, and 3
- Fried Octopus Recipe
- Planet Hop Activity Sheet