

# GRAPHING

## Lesson 1

### Objective

Students will:

- differentiate between a picture and a graph.
- identify a graph that represents a certain situation.

### Algebra Misconception Addressed by This Lesson

Students who are unclear on graph interpretation may consider a graph a picture of the event rather than a pictorial representation of data about the event.

### Rationale

In this lesson, students will view a computer applet (online tool) showing a picture of a real-world event (water flowing out of a tube). As animation shows how the picture changes, a graph is drawn to represent the event. Using this applet, students will observe that changing the parameters in the problem situation changes the graph, but not the picture. Since one of the graphing misconceptions algebra students have involves misinterpreting a graph as a picture, this activity sets the stage for a discussion of the differences between a graph and a picture of an event.

### Materials

You will need:

- Paper and pencils
- Activity sheets
- Computer with Internet access

### Definitions

Graph:

- a way to display data; examples include a line graph or a scatter plot.

Line graph:

- a data display that shows points connected by line segments; often used to show changes over time

$x$ -axis:

- the horizontal number line in a coordinate graph

$y$ -axis:

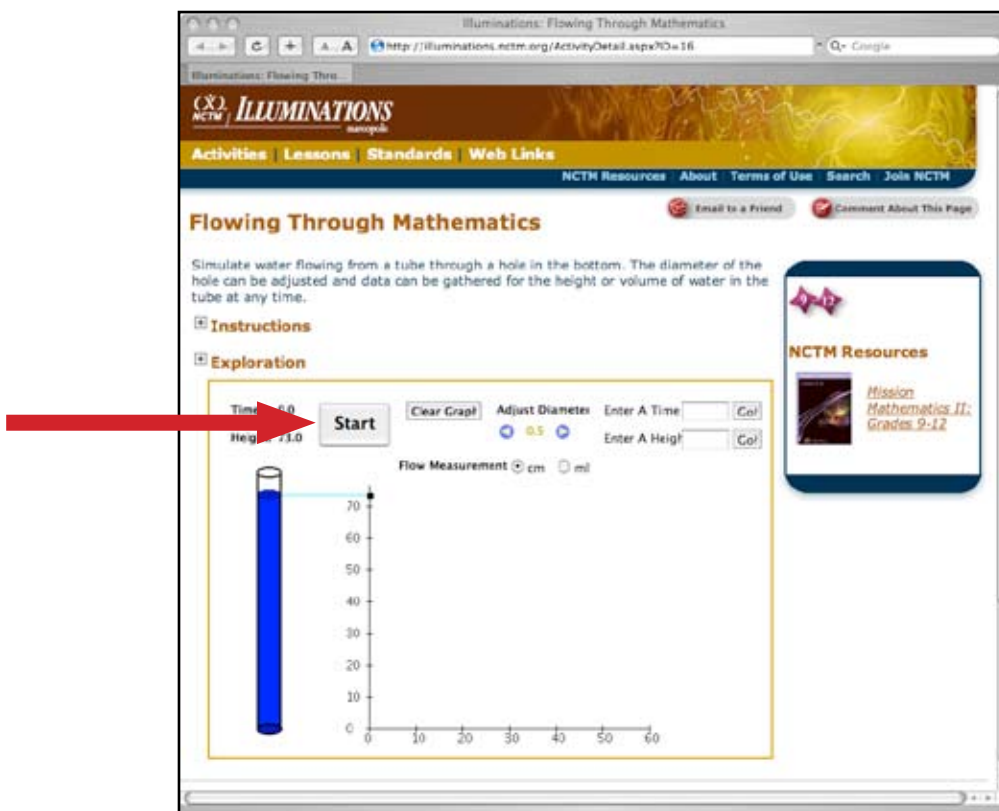
- the vertical number line in a coordinate graph



**Small-Group  
or Individual  
Instruction**

**Activity 1**

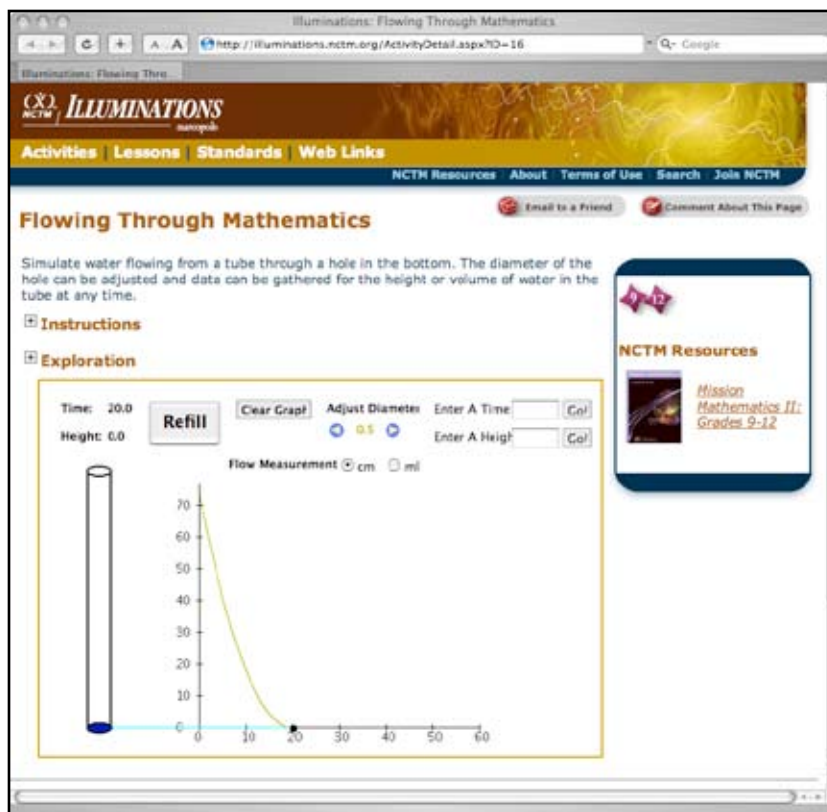
1. On a computer, navigate to the following website:  
<http://illuminations.nctm.org/ActivityDetail.aspx?ID=16>  
This applet will show an animation of water flowing out of a tube. As the water flows out, the applet represents this event with both a picture and a graph.
2. Have students gather around the computer screen (or look on their own computers, or use overhead). Show students that the tube on the left contains water. Ask students to imagine that this tube has a hole in the bottom that is 0.5 unit in diameter. Ask students what will happen to the tube as water flows through the hole in its bottom. Students should indicate that the water level in the tube will drop vertically. Then run the applet by hitting “Start.”



## Small-Group or Individual Instruction

### Activity 1 (continued)

- Point out to students that two diagrams were drawn when you ran the applet. Ask students, “Which showed a picture of water flowing out of the tube?” Students should reply that the picture is on the left. Then ask, “Which showed a graph of that same event?” Students should reply that the graph is on the right. The axes of the graph are not labeled but ask students if they have figured out what each axis shows. (You may wish to run the applet again to help them.) If students do not volunteer the answer, explain that the  $x$ -axis shows time, and the  $y$ -axis shows the height of water in the tube.

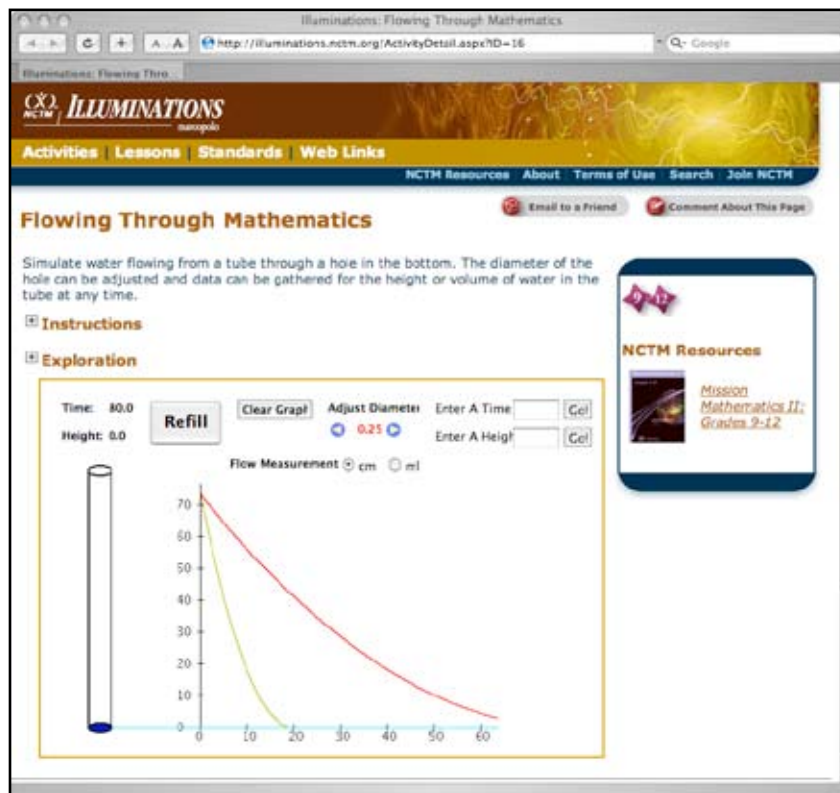


- Explain that both the picture and the graph represent what happens to the height, in centimeters, of the water in the tube as it flows out of the hole in the bottom. Ask students to describe how the picture differs from the graph. Lead the discussion to include the fact that the picture represents the height of the water in the tube and shows how it drops as water flows out of the tube. The graph represents how the height of water in the tube changes as time passes. If students do not do so themselves, point out how the water level in the picture drops vertically, but the line in the graph drops vertically *and* moves from left to right. This is because the graph actually shows more than the picture. It shows how the drop in water level is related to the time, in seconds.

## Small-Group or Individual Instruction

### Activity 1 (continued)

- Without clearing the graph on the applet, change the diameter of the hole to 0.25 unit. Explain to students that this makes the hole smaller.
  - Press the arrows to the left of the number beneath the words “Adjust diameter” to change the diameter to 0.25. Hit “Start” to run the applet.
  - Ask students to describe what happened when water flowed out of this smaller hole. Students may notice that it took longer for the water in the tube to drop, and this is shown on the graph by the fact that the line moves further to the right than the original graph. The first line ends before the 20-second mark on the  $x$ -axis because it took less than 20 seconds for the tube to drain when its hole was 0.5 unit in diameter. However, at the 20-second mark, the second graph shows that the height of water in the tube is still about 40 centimeters—more than half full—when the hole was 0.25 unit in diameter. The picture showed essentially the same thing both times—it showed the water level dropping in the tube. The graph, however, showed different things depending on the size of the hole.



**Small-Group  
or Individual  
Instruction**

**Activity 2**

1. Hand out an Activity Sheet to each student. Then choose a student to read the problem situation aloud. Ask a question or two to be sure that students comprehend the problem before moving on.
2. Below the problem is a chart. Model how students can use a chart, like the one given, to understand what is happening in the problem. For example, ask students to indicate how many miles the cyclist bikes, on average, over the course of the first three hours. Since he bikes at 10 miles per hour, he bikes for  $3 \times 10$ , or 30, miles in 3 hours. Write a 30 beside the 3 in the chart and have students copy this on their sheets.
3. Ask students how many miles the cyclist bikes over the course of his 2-hour break. Since he is stopped, he bikes for 0 miles. That means, by the 5<sup>th</sup> hour, he has still only biked 30 miles in total. Write a 30 beside the 5 in the chart and have students copy this on their sheets.
4. Ask students how many miles the cyclist bikes during the last hour. He bikes 12 miles per hour for 1 hour, so he bikes 12 more miles. That means by the 6<sup>th</sup> hour, he has biked a total of  $30 + 12$ , or 42, miles. Write a 42 beside the 6 in the chart and have students copy this on their sheets. The completed chart should look like this:

<b>Time (in hours)</b>	<b>Total Distance (in miles)</b>
0	0
1	
2	
3	30
4	
5	30
6	42

**Small-Group  
or Individual  
Instruction**

**Activity 2**  
*(continued)*

5. Direct students to use the data in the table to help them decide which graph best describes the problem. Students should notice that the points  $(0, 0)$ ,  $(3, 30)$ ,  $(5, 30)$  and  $(6, 42)$  only appear on the graph on the left. So, A is the correct answer.
6. Discuss with students why a student might be tempted to choose B as the answer. Students may indicate that the graph on the right models the terrain the cyclist is traveling over, like hilly roads for the first 3 hours and traveling to the top of a small hill for the last hour. A student who does not understand the difference between a picture and a graph might be tempted to choose B, the picture.
7. Remind students that a graph differs from a picture in that it does not necessarily show the real-life event. Instead it shows how data changes or stays the same, often over time.
8. To be sure students understand why the first graph is correct, question them about the graph. For example, ask students why (with the exception of the horizontal line between the 3-hour and 5-hour marks) the overall line on this graph slants upward. Students should indicate that the parts of the line that fall between 0 and 3 hours and between 5 and 6 hours slant upward because during those times, the total distance traveled is increasing. The part of the line between the 3-hour and 5-hour marks is horizontal and does not rise because during those 2 hours, the cyclist has stopped and the total distance traveled stays the same. This discussion may deepen students' understanding of how the graph represents the problem situation, and will provide an introduction to the concept of slope, which is covered in greater depth in Graphing, Lesson 2.



**Independent Practice**

1. The Independent Practice Questions are similar to the instructional activities because they will require students to identify or interpret graphs for problem situations. Each question also includes an answer choice which may be a tempting choice for any student who is still having difficulty differentiating between a graph and a picture.
  2. Assign Questions 1–10 only for either classwork or homework.
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**Assessment**

1. Review students' answers for the Independent Practice and verify that the recorded work is correct.
  2. If students had difficulty with the assignment, review how to solve several of the problems and how to show work for those problems. Then, allow students to redo Questions 1–10. Assign Questions 11–15 for additional practice.
  3. Once students have attained sufficient mastery of this lesson, move on to Graphing, Lesson 2.
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**Solutions to Independent Practice Questions**

1. B (C indicates a possible misconception.)
  2. D (C indicates a possible misconception.)
  3. A (B indicates a possible misconception.)
  4. A (D indicates a possible misconception.)
  5. B (D indicates a possible misconception.)
  6. A (C indicates a possible misconception.)
  7. B (A indicates a possible misconception.)
  8. C (A indicates a possible misconception.)
  9. B (D indicates a possible misconception.)
  10. B (D indicates a possible misconception.)
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**Solutions to Extra Practice Questions**

11. C (A indicates a possible misconception.)
  12. A (C indicates a possible misconception.)
  13. A (B indicates a possible misconception.)
  14. D (C indicates a possible misconception.)
  15. B (C indicates a possible misconception.)
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