

Overall Theme: *Translation between mathematics and a contextual situation*

Overall Goals:

- Lesson will emphasize the meaning of graphs.
- Lesson will convey some necessity, importance, beauty of mathematics
- Lesson will focus on conceptual versus procedural understanding.

Content Theme: *Modeling Change*

The Big Question: *How can change be represented graphically?*

Content Goals:

Students should be able to explain how graphs represent change and can tell “stories” with graphs. Students can create a real-life scenario for a given graph and conversely can sketch a graph using a description of a situation (“a story”). Students should be able to label graphs using appropriate units for a situation and recognize that one graph can describe more than one situation. Students should be able to describe rate of change in a graph, the relationship between independent and dependent variables, and explain how this relationship is represented in the graph.

Materials:

- balloons
- post-it chart paper
- double-sided tape
- markers
- blank paper, pens/pencils at each desk
- graph/grid paper
- large, color cards for tables, students (student cards folded in $\frac{1}{2}$)
- worksheets for Activity #1 and #2
- various questions pre-written on poster paper
- 8 graphs from Part I enlarged on poster paper

Activity (Time)	Description	Questions	Student Responses	Materials/ Preparation
<p>Launch (3 min.)</p>	<p><i>Balloon Observation:</i> Teacher blows up a balloon, slowly, then quickly, releases some air, etc... Students think about what is changing from the observation. When the teacher has finished the demonstration, teacher calls on volunteers. Responses will be recorded on the board/ flip-chart. <i>Ex: size, shape, air, surface area, volume, color, length, words, sound, time, etc.</i></p> <p>Teacher uses list to begin short discussion about what changed and HOW. Students are asked to “analyze” list in terms of different kinds of change.</p>	<p><i>“I want you to think about changes in the balloon as I blow it up.”</i></p> <p><i>“What was changing about the balloon?”</i> <i>What is different about the balloon?</i> <i>What do you know changed that you can’t SEE?</i></p>		<p>- balloons! - poster of graph should be up</p>

<p>Activity 1.a (5 min.)</p>	<p><i>Graph to Story – Part I:</i> Pairs of students are given the first graph and asked to explain what is happening to the balloon. Each student must write down the story they create. Teacher will emphasize that stories do not have to do with the way the teacher blew up the balloon, just how a balloon can change.</p> <p>Teacher will give students thirty seconds to clarify the directions with their partners. After answering the questions that come up as a class, all pairs start working on their stories.</p> <p>Teacher will circulate as the students discuss and write to make sure everyone is on-task. During this time the teacher will also “choose” two or three student pairs to share their description. Teacher can look for different ways students described “size,” for example.</p>	<p><i>This graph represents change in a balloon.</i> <i>Write a situation for this graph that describes how the balloon is changing.</i></p> <p><i>What is changing?</i> <i>What causes this change?</i> <i>What does the change depend on?</i> <i>Is anything changing at the same time? Do these things affect each other?</i></p> <p><i>Why were you able to come up with different ideas?</i></p>	<ul style="list-style-type: none"> - Time and Size - Time and Inflation - Time and “Stretch” - Speed of Inflation - Picture on balloon - Axes labeled or not - Units labeled or not <p><i>What labels should I put?</i></p>	<ul style="list-style-type: none"> - Worksheets for each student - Worksheet “blown-up” on a poster and hung up

<p>Activity 1.b (20 min.)</p>	<p><i>Sharing of Ideas:</i> Chosen pairs will be asked to describe what is happening in the graph. Teacher will call on students and facilitate a short discussion about each graph. (Option #2: Student pairs will switch graphs and will be asked to analyze the graph given to them. Does the story the other pair wrote match the graph? Why or why not?)</p> <p>Teacher can pick a point on the graph and ask students what is happening in their story at this point. Teacher can pick another point, for example with the same y-coordinate, and ask students what happened between the two.</p> <p>Teacher can draw angular representation of the graph and ask what is different. Students should understand the difference between immediate and gradual change.</p> <p>Teacher can make sure vocabulary students use in the discussion is correct.</p> <p>It is imperative that teacher uses student work to facilitate discussion. Teacher can easily use mistakes, misconceptions, arguments, etc. of students to discuss main ideas.</p> <p>** Closure: Teacher can ask a student or two to summarize how the graph shows change. The idea that our graph shows a big change, no change, then a smaller change is key.</p> <p>Key ideas that should emerge are rate of</p>	<p><i>Can someone other than [authors of the story] explain how you think this story describes the graph well or not?</i></p> <p><i>What is the same about these two points? What is different? What happened between them?</i> <i>How did you know this was happening here?</i></p> <p><i>What was the difference between ___'s story and ___'s story.</i></p> <p><i>Bill, what do you think is changing in ___'s story? How is it changing? What do you think is causing the change?</i></p> <p><i>How do I show this on my graph? How does this show up on the graph?</i></p> <p><i>What if I used a helium tank to blow up the balloon?</i> <i>What if I change this part of the graph to look like this?</i> <i>Where is the deflated balloon represented on the graph?</i> <i>What if this part of the graph was less steep?</i></p>	<p>Students may become unsure of the labels on the axes after class discussion.</p>	
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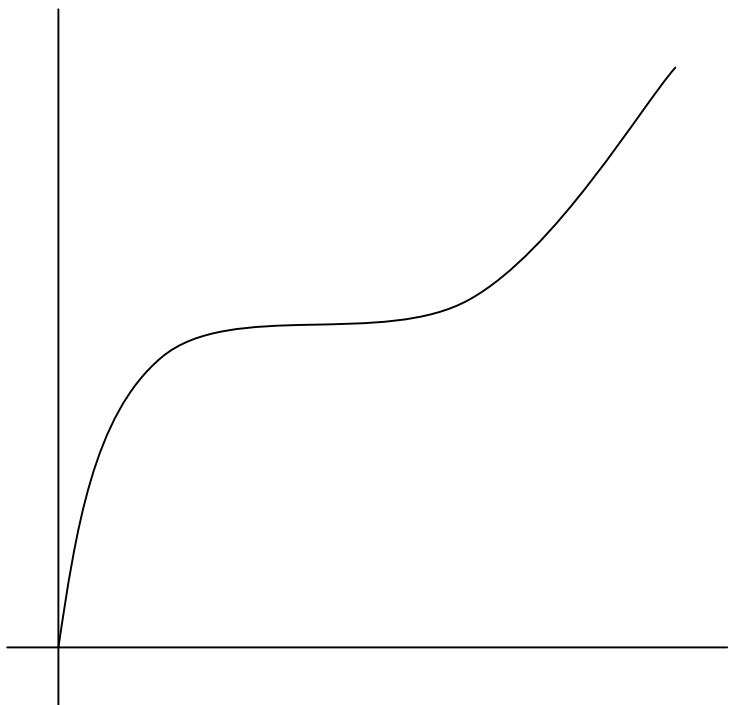
	change and the idea that the graph shows a relationship between two things. Students should also understand that “the flat part” of the graph represents something not changing.			
Activity 2.a (5 min.)	<p><i>Graph to Story – Part II:</i> Pairs of students are given the same graph again and asked to use it to write a new story. Each student must write down the story the pair creates. Students are <i>not</i> expected or encouraged to use a balloon in their new story.</p> <p>Again, teacher will circulate around the room checking for understanding. Students will be given graph on large paper to provide labels, title, etc.</p>	<p><i>Think of a new story for the same graph that has nothing to do with a balloon.</i></p>	<p><i>Can we use a balloon anyway?</i> <i>Do we need to label our graphs?</i> <i>I can't think of anything.</i> <i>Do I have to use this [axis] that you gave me?</i></p>	

<p>Activity 2.b (25 min.)</p>	<p><i>Sharing of Ideas:</i> Each pair will share the description of the story while teacher notes key ideas on chart paper. Other students are given the opportunity to ask questions about the story. The sharing should be quick and should emphasize how many different ways there are to interpret a graph. Students from the audience can be asked to describe the story just using the graph.</p> <p>Teacher should be cautious about which students present before others. Teacher needs to look at each graph carefully before the discussion begins and be ready to bring up key points in desired order.</p> <p>At the end of the activity students should see how one graph can represent many different situations. Also, students should see how a graph can represent change. Students should understand the idea of independent and dependent variables and should understand the concept of slope as rate of change. This vocabulary may or may not be used.</p>	<p><i>What is changing?</i> <i>How is it changing?</i> <i>What is causing that change?</i></p> <p><i>Megan, do you think Claudia’s story describes this graph?</i></p> <p><i>What does (speed) have to do with (time) in this graph?</i></p> <p><i>How does this point in Bill’s graph compare to this point in Remy’s graph? Does the point mean the same thing? Why?</i></p> <p><i>If we change this label to _____, what changes about our story? Does it still make sense?</i></p>		
<p>Activity 3 (if time)</p>	<p><i>Story to Graph:</i> Students are given two situations and are asked to sketch a graph to represent them (on a single axis).</p> <p>Depending on time, students will draw graphs with partners or “as a class.” Discussion will involve the entire group.</p> <p>This can also be a homework assignment.</p>	<p><i>How can change be represented graphically?</i> <i>What is changing?</i> <i>How is it changing?</i></p> <p><i>When should the slope be different?</i> <i>How is this like the graphs from the balloon?</i></p> <p><i>How can your graph be</i></p>	<p><i>Why is it flatter here and steeper there?</i></p>	

		<p><i>more accurate?</i> <i>What does this graph tell us?</i></p>		
<p>Wrap-up (2 min.)</p>	<p>Teacher will build from visible work to make concluding points about the lesson. <i>What was the goal?</i> The important ideas that should surface at this time are rate of change (+/-, slopes, steepness, going through the origin, etc.), labeling, independent and dependent variables and the idea that a story can be represented with a graph and vice-versa.</p> <p>Students will leave all materials from the lesson in the classroom for later review by teacher and observers.</p> <p>Students clean up and are dismissed.</p>	<p><i>Today we talked about change. In this graph, we looked at a graph that represented the change in a balloon...</i></p> <p><i>What was this lesson about?</i> <i>What can you tell me about change?</i></p> <p><i>What is change?</i></p>		

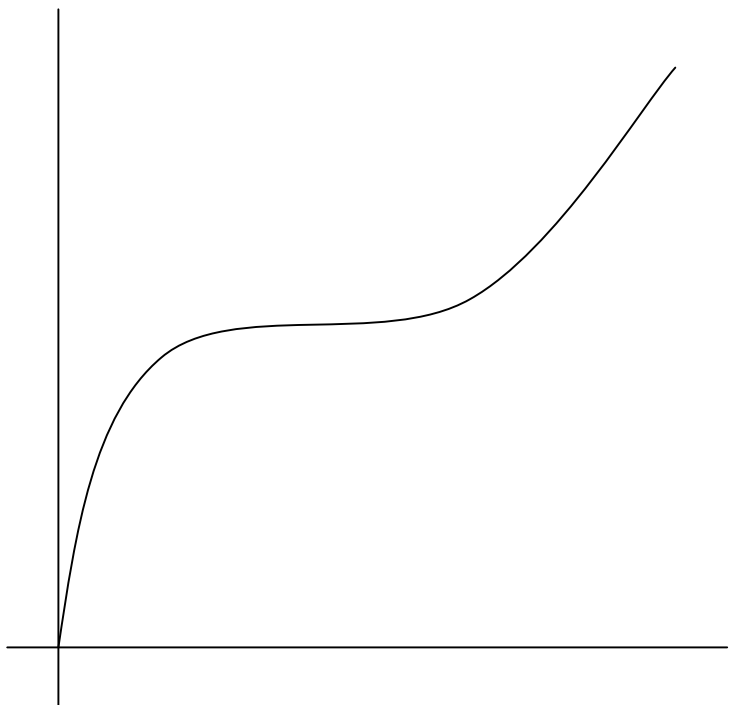
Graph to Situation – Part I

DIRECTIONS: Create a story about a balloon for the graph below in one or two sentences.



Graph to Situation – Part II

DIRECTIONS: Create another story for the same graph in one or two sentences.



Story to Graph – Part III

DIRECTIONS: *Sketch a graph for the situations below.*

1. (a.) Lance Armstrong rode up and over a mountain pass in the Alps. Draw a graph to represent his ride.
(b.) Lance overtook his rival, Ivan Basso, during the ascent.

