Comparing Motion to Trajectory with the Qualitative Grapher

Most people view a distance-versus-time graph as a picture of an object's path through space—its trajectory. But the graph of an object's movement may look different from its trajectory. Using the Qualitative Grapher, accessible at http://seeingmath.concord.org/resources_files/QGrapher.html, you can gain insight into this distinction and the difficulties students face in learning to interpret graphs.

The Activity

You're about to use a program called the Qualitative Grapher (or Q-grapher) to create graphs of time and motion.

This activity has three purposes:

- To help you get comfortable with an interactive.
- To let you do some playful online math experiments and see if your predictions pan out. In the process, you get comfortable interpreting graphs of time vs. distance, and gain insight into your own thinking and into the difficulties a student might experience with such graphs.
- To begin a journal of your mathematical journey.

Instructions

The Q-grapher allows you to watch an object move in response to a time vs. motion graph that you create.

Read all the instructions below before you begin, including the ones below the Q-grapher itself, then try out the Q-grapher.

Using the Q-grapher

The x-axis shows time in seconds. The y-axis shows the height of the object (a box or other shape) at each second. All graphs are continuous.

- To add a straight or curved line to the graph, click the desired icon just below the graph. (There are two line segments already in the graph.)
- To change the position or angle of any line, drag its "handles" (■).
- To remove the most recently added line segment, click ⬅
- Click ▶ to start an object moving. You can pause or stop the motion as well using the other buttons.
- Watch the motion of the object on the left as it moves with the graph. As it goes up or down, a red line moves across the graph.

Predict and Play

As you work, jot down predictions and observations. Note your reactions. Does the grapher surprise you? Does the experience of using the grapher differ from answering similar questions with paper and pencil?

1. Study the graph and try to predict the motion of the object. How will it move? For example, does its height stay the same for a period of time?
2. Click play. Did the motion match what you thought would happen?
3. Change the position of any line by grabbing its "handles". Predict the motion, and play again.
4. Add and delete line segments. Predict and play!

The Trickster Squirrel

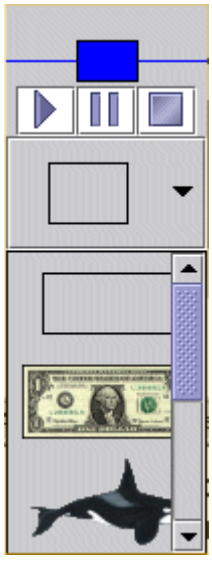
Turn the experiment into a story of The Trickster Squirrel. Imagine that you throw a ball straight up in the air, but there is a mischievous squirrel in the tree overhead. Construct graphs for the following stories:

- You throw the ball up. The squirrel catches it, holds it for a count of three, then drops it onto your head.
- You throw the ball up. The squirrel catches it, holds it for one second, then throws it up even higher. Then the ball falls onto your head.
- You throw the ball up. The squirrel catches it, holds it for a moment, then rolls the ball back down along a long, trailing branch to the ground.

How does the line of this graph compare to the trajectory of the ball? List all the similarities and differences you observe.

Moneybags

Now imagine the object is not a ball but a money bag. Make up your own story about a sum of money that grows and shrinks over time. Change the moving image to a dollar bill:



Do you find that you view, or tend to view, the graph differently when graphing money from the way you viewed it when graphing a ball?