Dueling Runners (Time Distance Graphs)

Lesson Overview

In this lesson, students will connect their understanding of linear functions to time distance graphs by using a computer simulation.

This is Lesson 4 in a series of lessons that should be part of a larger unit that includes student practice problems, quizzes, tests, and materials for reteaching if needed.

Alignment

Science Standards

SC 2014 8.P.2A.6 Use mathematical and computational thinking to generate graphs that represent the motion of an object's position and speed as a function of time.

Science and Engineering Practices

SEP 4: Analyze and interpret data.
SEP 5: Use mathematical and computational thinking.
SEP 6: Construct explanations.

Crosscutting Concepts (from the SDE instructional unit resources document)

2. **Cause and effect**: The National Research Council states "events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts" (p. 84).

Math Standards

SCCCR Math 8.F.3 Investigate the differences between linear and nonlinear functions using multiple representations (i.e., tables, graphs, equations, and verbal descriptions).

a. Define an equation in slope-intercept form $(y=mx+b)$ as being a linear function.
b. Recognize that the graph of a linear function has a constant rate of change.
c. Provide examples of nonlinear functions.

(Note: The focus in this series of lessons is on linear functions, as highlighted above. The rest of this standard is addressed in a different series of lessons in this unit.)

Standards for Mathematical Practice

Standard 1: Make sense of problems and persevere in solving them.
Standard 3: Use critical thinking skills to justify mathematical reasoning and critique the reasoning of others.
Standard 5: Use a variety of mathematical tools effectively and strategically.
Standard 7: Identify and utilize structure and patterns.

ELA Inquiry Standards

Standard 3: Construct knowledge, applying disciplinary concepts and tools, to build deeper understanding of the world through exploration.

3.1 Develop a plan of action by using discipline-specific strategies.

3.4 Organize and categorize important information, revise ideas, and report relevant findings.

ELA Writing Standards

Standard 6: Write independently, legibly, and routinely for a variety of tasks, purposes, and audiences over short and extended time frames.

6.1 Write routinely and persevere in writing tasks over short and extended time frames, for a range of domain-specific tasks, and for a variety of purposes and audiences.

ELA Communication

Standard 1 Interact with others to explore ideas and concepts, communicate meaning, and develop logical interpretation through collaborative conversations; build upon the ideas of others to clearly express one's own views while respecting diverse perspectives.

1.2 Initiate and participate effectively in a range of collaborative discussions with diverse partners; build on the ideas of others and express own ideas clearly and persuasively.

1.4 Engage in dialogue with peers and adults to explore meaning and interaction of ideas, concepts, and elements of text, reflecting, constructing, and articulating new understandings.

1.5 Synthesize areas of agreement and disagreement including justification for personal perspective; revise conclusions based on new evidence.

Connections

Content Area (2 or more) Connections

- Science
- Math

Content Connections

The computer simulation provides students the opportunity to explore time distance graphs and make connections to linear functions.

Active Learning Strategies (for Purposeful Reading, Meaningful Writing, and Productive Dialogue)

- Pairs Squared
- Making Thinking Visible

Computational Thinking

Students use technology to connect time distance graphs to the concepts they explored in Lessons 1 and 2. Thus, the work in this lesson is an extension of those big ideas: slope, constant rate of change, speed, time, and distance. Students must work together and persist in identifying and analyzing those connections.

*Computational thinking (CT) is a problem-solving process that includes (but is not limited to) the following **characteristics**:*

- Confidence in dealing with complexity
- Persistence in working with difficult problems
- The ability to communicate and work with others to achieve a common goal or solution

*These skills are supported and enhanced by a number of dispositions or attitudes that are essential dimensions of CT. These **dispositions or attitudes** include:*

- Confidence in dealing with complexity

- Persistence in working with difficult problems
- The ability to communicate and work with others to achieve a common goal or solution

Lesson Plan

Time Required – 60 minutes

Disciplinary Vocabulary – speed, position, direction, distance, stride, distance-time graph, slope (as it describes relative speed)

Materials Needed:

Standard Materials:

- Student Math notebooks
- Sheets of 11 x 17 paper (1 for every 2 students)
- Markers or colored pencils

Handouts:

- Distance-time Graphs handout

Technology:

- Internet access
- Distance, Speed, & Time Simulation http://illuminations.nctm.org/Activity.aspx?id=6641 – requires Java

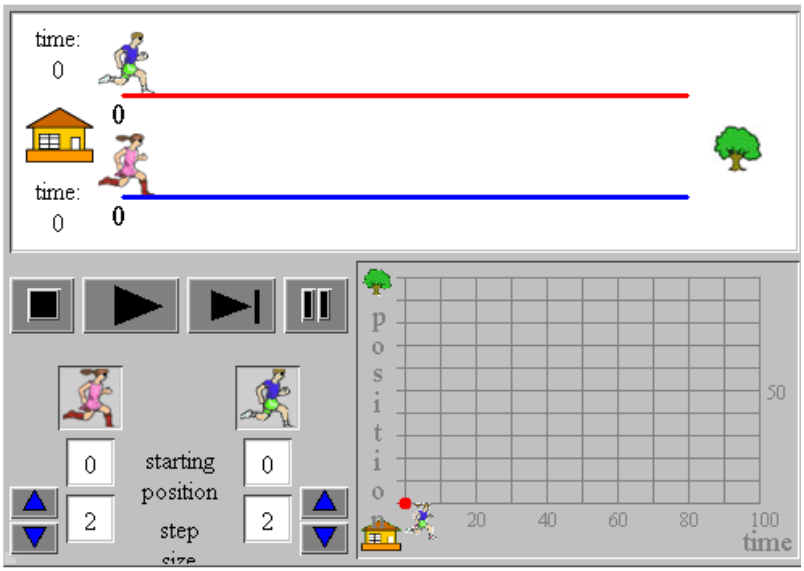
Formative Assessment Strategies: Student dialogue, Distance-time Graphs handout, Making Thinking Visible

Misconceptions: None noted

Safety Note(s): N/A

Engage

- Direct students to the url for the Runners' Applet and walk them through how to use it.



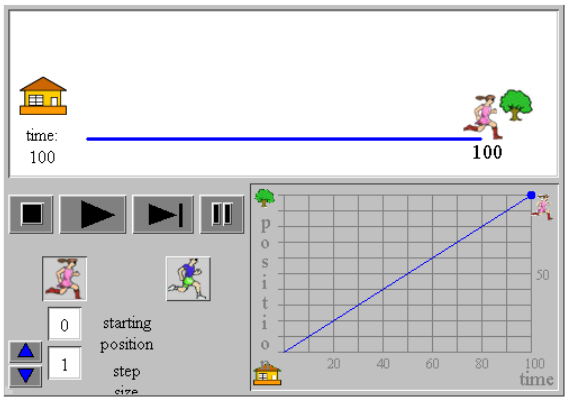
- Buttons in the white area:
  - Change the direction of the runners by clicking on them.
  - Change the position of the runners by sliding them along the line between the home and the tree.
- Buttons in the gray area:
  - The Black Square is a reset button and will return the runners to their starting positions.
  - The Black Arrow is a play button that allows you to view the runners moving until they reach their destinations.
  - The Black Arrow with the horizontial line allows you to view the runners in slow motion.
  - The Blue Arrows on either side of the "step size" allow you to alter the length of each runners step.
  - The runner buttons (both pink and blue) can be used to remove the runners from the race.
- Give students time to practice using the controls.

Explore

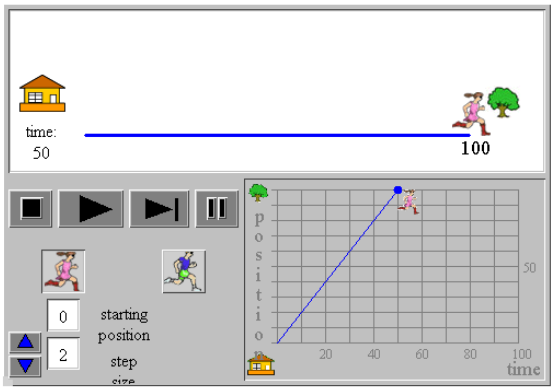
- Students work with their partners to complete the Distance-time Graphs handout.
- Circulate and ask guiding questions to check student progress and understanding.

- Some students may need more guidance than others. If this is the case, walk students through each section of Simulation Exploration.

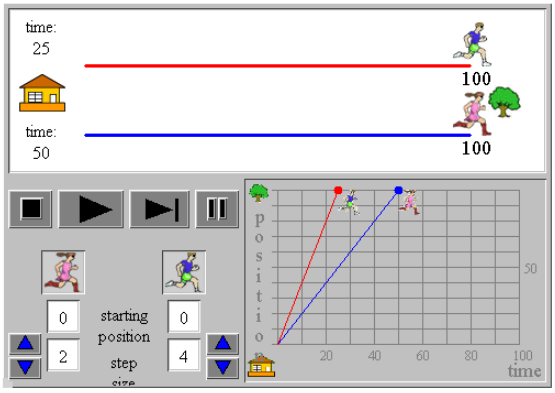
Step size: 1



Step size: 2



Two runners



Explain

Part 1

- Have pairs of students form squares (groups of four) and compare their work.
- Lead a whole class discussion about the graphs on the Distance-time Graphs handout. Points that should be brought out include:
  - Faster speed = steeper slope.
  - The impact step size has on the graph.

Part 2: Making Thinking Visible

- Give each pair of students a Making Thinking Visible card, a sheet of 11 x 17 paper, and colored pencils or markers.
- Each pair creates a Making Thinking Visible poster displaying the information detailed on their cards. There are three cards included in the handouts for this lesson. More graphs may be generated using the Applet to create additional cards.

Extend

Place the blue runner at position 75 facing the house and the pink runner at position 20 facing the tree.

- What step sizes must you give each runner for each of them to reach their destinations in the same amount of time?
- If they do reach their destinations in the same amount of time, who wins the race? Why?
- If the race ended in a tie, what can you conclude about the speed of each runner?

HANDOUTS FOR LESSON BEGIN ON THE FOLLOWING PAGE

Distance-time Graphs

Name _____

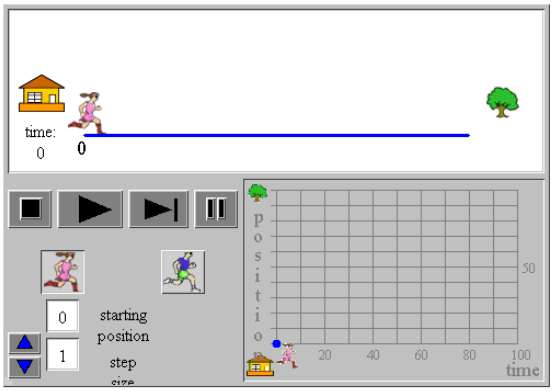
Partner _____

Date _____ Class pd _____

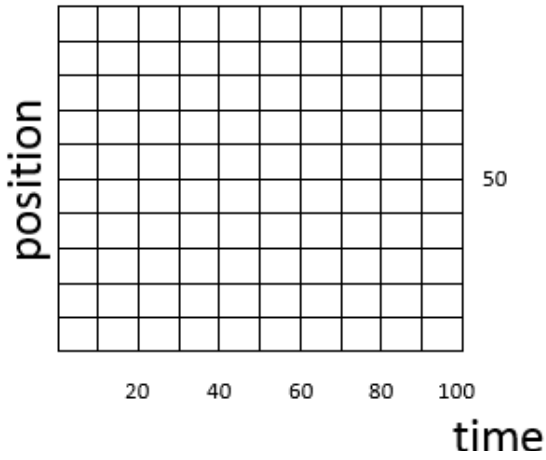
All graphs were generated using the Distance, Speed, & Time Simulation Applet at
http://illuminations.nctm.org/Activity.aspx?id=6641

One Runner

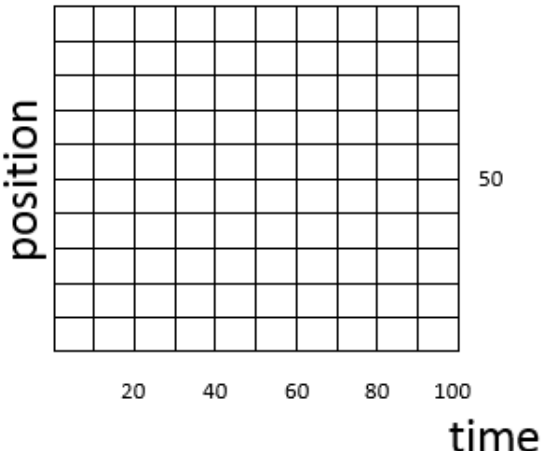
- In the gray area, click on one of the runners to remove it. The illustration shows the pink runner; but you can choose to use the blue runner if you like.
- In the white area, move the runner to the zero position and make sure it is facing the tree.



Set the step size to **1.**
Click play. Sketch the graph.



Set the step size to **2.**
Click play. Sketch the graph.

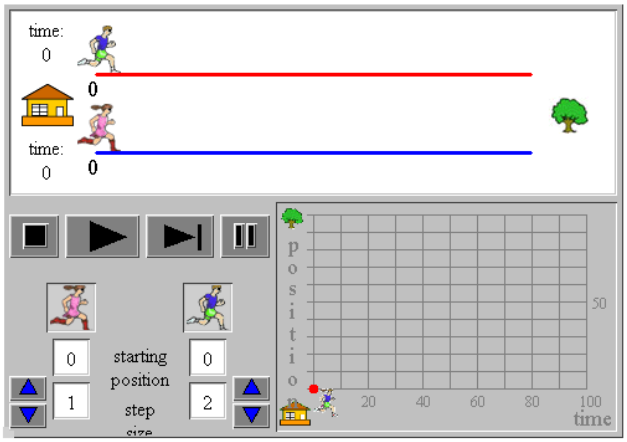


How does changing the step size change the graph? Be sure to include time and speed in your answer.

Two Runners

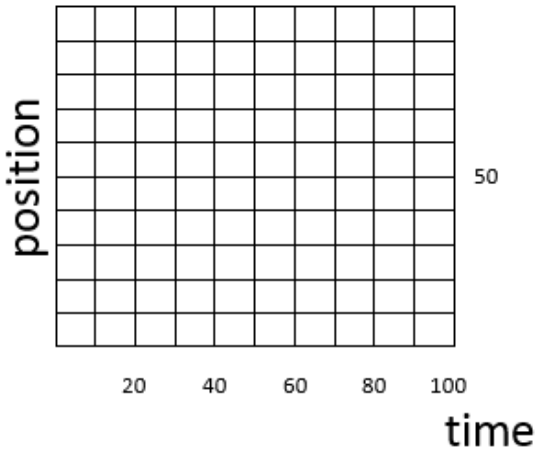
- In the gray area, click to bring the second runner back to the race.
- In the white area, move each runner to the house at the zero position. Make sure both runners are facing the tree.
- Set the step size for the blue runner at 4.
- Set the step size for the pink runner at 2.

Hit the play arrow and observe the runners. You can hit the reset button as often as you need to in order to answer the questions below.



	BLUE RUNNER	PINK RUNNER
How much time did it take each runner to reach the tree?		
What is the position of each runner at the beginning of the race?		
What was the position of each runner at the end of the race?		
What was the total distance traveled by each runner?		

Sketch the graph.



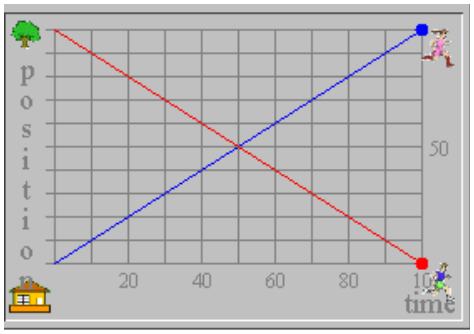
What on the graph is the same for both runners?

What on the graph is different for both runners?

Who won the race? What evidence does the graph give you to support your answer?

MTV Card 1

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.

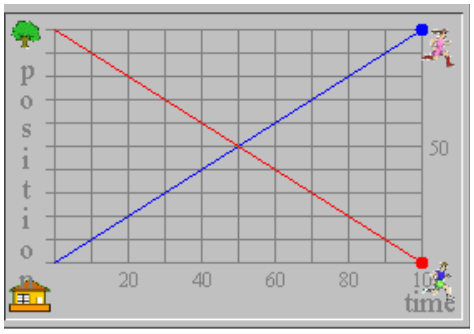


APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.

MTV Card 1

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.

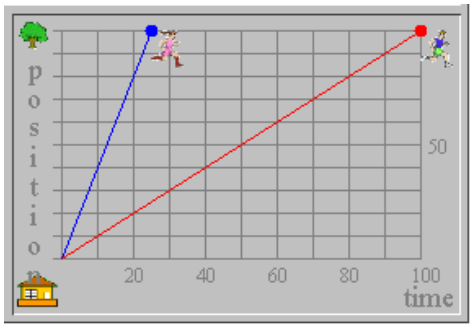


APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.

MTV Card 2

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.

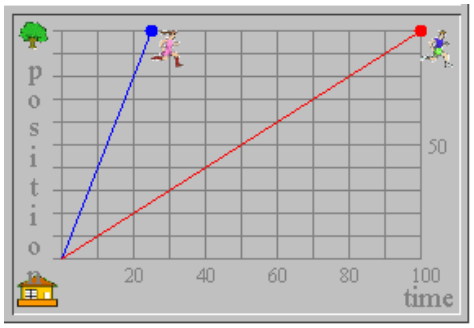


APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.

MTV Card 2

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.

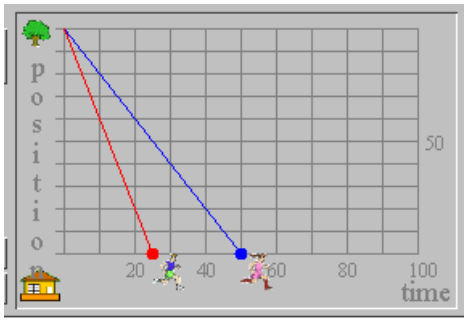


APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.

MTV Card 3

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.

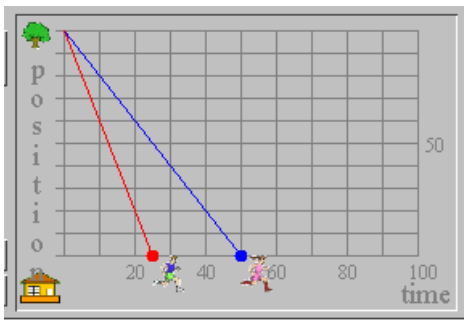


APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.

MTV Card 3

- Use the Applet to find and record the settings that match the graph.
- Answer the questions.
- Create your Making Thinking Visible poster.



APPLET SETTINGS	BLUE RUNNER	PINK RUNNER
Step size:		
Position:		
Direction:		

- At what time during the race are the runners at the same position?
- How far does each run?
- How long does it take each to complete the race?
- Explain how you solved the problem.