Chapter 2

Rosalind Ali: Getting Ready to Ride

Rosalind Ali is a middle-grades Math and Algebra teacher in the Chicago Public School system. She holds a B.S. degree in Computer Science from the University of Detroit-Mercy and an M.S. degree in Education from Indiana University-Indianapolis. Rosalind began her professional career in the IT industry. Seeking new and exciting challenges, she earned teaching credentials at the University of Illinois-Chicago and just finished her 12th year as an educator.

Getting Ready to Ride (Data Tables and Graphs)

Grade Level: 6th

Content Area Topic: Algebra

Content Area Standard(s):
- 6.RP.A: Understand ratio concepts and use ratio reasoning to solve problems (6.RP.A.3a)
- 6.NS.C: Apply and extend previous understandings of numbers to the system of rational numbers (6.NS.C.8)
- 6.EE.C: Represent and analyze quantitative relationships between dependent and independent variables (6.EE.C.9)

Standards for Mathematical Practices:
Practice 1: Reason abstractly and quantitatively.
Students are engaged every day in solving problems and, over time, learn to persevere in solving them. To be effective, the problems embody critical concepts and skills and have the potential to engage students in making sense of mathematics. Students build understanding by reflecting, connecting, and communicating. These student-centered problem situations engage students in articulating the "knowns" in a problem situation and determining a logical solution pathway. The student-student and student-teacher dialogues help students not only to make sense of the problems, but also to persevere in finding appropriate strategies to solve them. The suggested questions in the Teacher Guides provide the metacognitive scaffolding to help students monitor and refine their problem-solving strategies.

Practice 4: Model with mathematics.
Students conduct a jumping-jack experiment to simulate a bike-riding trip. They make a table and graph of their experiment and evaluate their data. Students see that the difference between two adjacent table entries, divided by 10, tells the number of jumping jacks per second. They also see on their graphs that greater rates are shown by bigger jumps upward from one data point to the next.
Students identify and record their personal experiences with the Standards for Mathematical Practice during the Mathematical Reflections at the end of the Investigation.

Learning Objective(s):

- Students will be able to construct a graph using a variety of technologies from a table of data that depicts change over time.
- Student will be able to describe the pattern of change represented in the graph.

Suggested Time Allotment: 60-90 minutes

The goal of this Investigation is to develop students' ability to look for quantities that change over time, especially distance and speed of moving objects, and their ability to construct and interpret data tables and coordinate graphs representing patterns in that change. This introductory lesson should be followed with lessons that provide additional problem solving opportunities for students to create data tables, coordinate graphs and written descriptions of patterns of change. Students should be able to understand the value of each type of representation and determine when to use each. In this curriculum, these mathematical goals are pursued through work on four Problems in the context of planning and pilot-testing a three-day cross-country bicycle trip from Atlantic City, NJ, to Williamsburg, VA.

We suggest that you launch this Investigation with some class discussion of the bike tour context. You can use the information provided about the RAGBRAI (Register's Annual Great Bike Race Across Iowa) or find information and video clips of other similar bike tours that occur in many other states. You can move from that general discussion to the specific challenge of Problem 1.1 by asking students to think about this question: *How are the cyclists' speed and distance covered likely to change throughout a day?*

Materials & Resources Needed:

- Student Edition Problem 1.1 : vp1-1.doc (excerpt from Variables and Patterns, Connected Math)
- Labsheet 1.1A: Jumping Jack Fitness Test (labsheet 1-1a.doc)
- Labsheet 1.1B: Jumping Jack Tables and Graph (labsheet 1-1b.doc)
- Graph Paper and stop watches
- Launch Video http://media.pearsoncmg.com/curriculum/dash/courses/CMP3_TP_Grade6_0703/course_base/resources/content_module_513/assets/2C6D5CB4CFD0EC2D68B642C9C28E9782D8D599E4.mp4
- Web based graphing tool: http://nces.ed.gov/nceskids/createagraph/default.aspx
- RAGBRAI (Register's Annual Great Bike Race Across Iowa): http://ragbrai.com http://ragbrai.com/?s=video

Lesson Activities & Sequence:
This lesson is the third critical area of focus for 6th graders lesson in the sequence of materials they will cover in the year. Prior to this lesson students have studied ratios and proportional relationships and the number system. Students would be expected to know foundational mathematics including graphing in the first quadrant. The next lessons will allow students to have opportunities to reason about and solve one-variable equations and represent and analyze quantitative relationships between dependent and independent variables.

Lesson Activities:
- Do Now
- Launch
- Explore
- Summary
- Additional problems (early finishers, homework)

Details of each activity are provided below.
Do Now:
Task: Find the length, width and area of all rectangles with a perimeter of 24 meters. (whole number lengths & widths)
Describe the relationship between the length and areas of rectangles whose perimeter = 24 meters.

Do Now - Teacher Guide: Suggested Questions:
Describe the relationship between lengths and areas of rectangles that have fixed perimeters.
As the length increases, the area increases to a maximum point, and then it decreases in the same way (at the same rate) as it increased.

Display a completed table and graph of the data.

How did the relationship show up in a table and graph?
As the length increases, the area increases to a maximum point, and then it decreases in the same way (at the same rate) as it increased. The graph is a curve starting at the origin that increases until it reaches the maximum point. Then it decreases. The graph is symmetric with respect to a vertical line through the maximum point.
If needed, you may want to briefly review graphing in the first quadrant.

Launch: Presenting the Challenge
Tell the class about bicycles and the yearly bicycle tour across Iowa. Encourage students to share other facts about organized bicycle tours they might know. Then continue reading about the bicycle trip that the five college students are planning. Have students share their ideas

about the questions in the introduction. Students should justify their guesses about the distance they think they could ride in a day and consider ways in which their speed might vary throughout the day.

Suggested Questions:
How far do you think you could ride in a day?
Answers will vary.
How do you think the speed of your ride would change during the course of the day?
Most students will indicate that their speed would slow down over the course of the day as they grew fatigued. Others might say that they could get surges of energy, especially toward the end.
What conditions would affect the speed and distance you could ride?
Answers might include the type of terrain (rocky or smooth); how much of the ride is uphill, downhill, or flat; weather conditions and temperature; and how much gear you carry.
How are the cyclists' speed and distance likely to change throughout a day?
Answers will vary.

After a short class discussion, move on to the jumping jacks stamina experiment. Connect the bike tour and the jumping-jack experiment by pointing out that both activities involve physical exertion over a period of time. This experiment works best if students are divided into groups of four (five). Within the group, each student has a job: performing jumping jacks, counting jumps, timing when 10 seconds have passed, and recording the number of jumping jacks completed at the end of every 10 seconds for the 2-minute time period, and photo/video journalist to capture the experiment process digitally.

The directions suggest that students do jumping jacks for 2 minutes. If the time limit is too short (say, only 1 minute), then the jumping-jack rate is not as likely to change. Two minutes has worked well in many classes. We suggest that you tell students to talk to you if they are not physically able to do the experiment. Inform everyone that if they get tired they should stop. Every student does not need to jump. Many students like to volunteer.
You can show the Launch Video at this point, or have a group of four (five) students model the experiment in order to describe and clarify the roles of each person in the group. After describing the roles in the jumping-jack experiment, show this video to clarify the responsibilities for each member of the group.
Launch Video: http://media.pearsoncmg.com/curriculum/dash/courses/CMP3_TP_Grade6_0703/course_base/resources/content_module_513/assets/2C6D5CB4CFD0EC2D68B642C9C28E9782D8D599E4.mp4
Make sure students understand the emphasized points in Presenting the Challenge. Then, have them do the experiment.

Emphasize the following points:

- The jumper performs a complete jumping jack when he or she completes these three steps:
- Start with feet together and hands at sides.
- Jump, landing with legs apart and hands touching above the head.
- Jump again, returning to the starting position with feet together and hands at sides.
- The counter counts an additional jump each time the jumper returns to the starting position.
- The timer calls out "time" when each 10 seconds passes.
- The recorder listens for the timer to call "time" and then writes the last number the counter called into the table.
- Suggest that students make a table with the times from 10 seconds to 120 seconds, listed in 10-second intervals, before conducting the experiment. After the demonstration, give students copies of Labsheets 1.1A and 1.1B. Have students perform the experiment and then complete Problem 1.1. Have as many students as possible take a turn at each task. Remind them that they need to count and record the total number of jumping jacks their teammates complete by the end of each time interval.
- Ask for some predictions about the jumping-jack stamina experiment:
- How many jumping jacks do you think you could complete in 2 minutes?
- How do you think your jumping-jack rate would change over the 2-minute test?

Explore – Providing for Individual Needs: When students have collected their jumping-jack data in a table, check in with each group as they produce their graphs using paper and pencil AND electronically to be sure they are plotting pairs correctly. Some students may need guidance in placing appropriate scales on the x- and y-axes for the graphs. Question C of the Problem asks students to interpret the pattern in the data and to be prepared to explain how that pattern is shown in each representation—table and graph.

Suggested Questions:

- What patterns do you see in the graph? Explain.
- The total number of jumping jacks decreases. Because the number of jumping jacks in each interval decreases, the total decreases.
- Do the points lie on a straight line? No.
- What would it take to have the data points lie in a straight-line pattern? The jumper would have to jump the same number of jacks in each interval. This is unlikely to happen since the jumper will get tired and slow down.
- What pattern of growth do you observe between adjacent points? The number of jumping jacks per 10 secs decreases as time goes by.