

# PATTERNS & FUNCTIONS

## WORKSHOP 3: DISCOVERY

### Agenda for Two-Hour Workshop

**15 minutes**  
**Introduction**

*Workshop Facilitator/Site Leader*

Hand out the materials for Workshop 3. Discuss the following questions:

- What is the mathematics involved in the topic of Patterns & Functions?
- What is the connection between Patterns & Functions and algebra?
- Should all middle school students take algebra?
- How can algebra be taught more concretely?

**60 minutes**

*Whole Group*

#### **View Workshop 3: Patterns & Functions — Discovery**

While watching the program, consider the following focus questions:

- What algebra concepts are new to you?
- What concepts do you still have questions about?
- How does the concept of slope and y-intercept come out in the context of the different problems?
- One important idea in the study of algebra is the relationship between two variables. What is your understanding of independent and dependent variables? How would you help students distinguish between these two variables?
- How did the students from Wheeling approach the problems? What evidence do you see of their learning?
- Solving a system of equations is a standard topic in Algebra I. What does the solution to a system actually tell you?
- What problems involve the solution to a system of equations, and how is that solution important to the problem situation?
- In the student segment of Lesson 2: Charity Walkathons, did Steve understand what it meant when the two graphs intersected?
- In the same student segment, Jake makes this comment about the pledge plans: “I think they all can be right, depends on how far you walk.” Is he correct?

**40 minutes**

*Small Groups or with a Partner*

#### **Read, Do and Discuss**

Read Lesson 1: Predicting From Patterns.

Have all groups do one experiment. If time and supplies are an issue, all groups could do the same experiment (Circle, Ball Bounce and Ball Drop labs all produce interesting results).

Discuss findings, focusing on the above questions.

### **BEFORE WATCHING THIS PROGRAM ...**

- ▶ Make sure to have copies available of Lesson 1: Predicting From Patterns (page 43).
- ▶ Have materials for Lesson 1:
  - Balls
  - Meter sticks
  - Tape measures
  - Circular objects
  - String (optional)
  - Rubber bands
  - Weights
  - Paper clips
  - Paper bridges
  - Pennies
  - Lab sheets.
- ▶ Have materials for Lesson 2 for teachers to take home:
  - Large chart paper
  - Markers.
- ▶ Have materials for Lesson 3 for teachers to take home:
  - Graph paper
  - Large chart paper
  - Markers
  - Calculators.

**5 minutes**

***Workshop Facilitator/Site Leader***

**Homework Assignment**

- Do Lesson 2: Charity Walkathons and Lesson 3: Buying T-Shirts.
- Look at the sample student work for Lesson 3 (page 64).
- Review the Launch-Explore-Summarize Teaching Model (page 152).
- Review the Why This Topic Matters section (page 74).
- Use your journal to reflect on the focus questions from this workshop. Describe how these lessons deepened your content knowledge about Patterns & Functions. What did you learn? What else do you need to learn?

# PATTERNS & FUNCTIONS

## WORKSHOP 3: DISCOVERY

### Agenda for Four-Hour Workshop

**20 minutes**  
**Introduction**

*Workshop Facilitator/Site Leader*

Hand out the materials for Workshop 3. Discuss the following questions:

- What is the mathematics involved in the topic of Patterns & Functions?
- What is the connection between Patterns & Functions and algebra?
- Should all middle school students take algebra?
- How can algebra be taught more concretely?

**20 minutes**

*Whole Group*

#### **View Lesson 1: Predicting From Patterns**

While watching the program, consider the following focus questions:

- What are the core concepts from this lesson?
- One important idea in the study of algebra is the relationship between two variables. What is your understanding of independent and dependent variables? How would you help students distinguish between these two variables?
- How does the concept of slope and y-intercept come out in the context of the different experiments?
- How did the students from Wheeling approach the problems? What evidence do you see of their learning?

**40 minutes**

*Small Groups or with a Partner*

#### **Read, Do and Discuss**

Read Lesson 1: Predicting From Patterns.

Have all groups do one experiment. If time and supplies are an issue, all groups could do the same experiment (Circle, Ball Bounce and Ball Drop labs all produce interesting results).

Discuss findings, focusing on the above questions.

**20 minutes**  
**Discuss**

*Whole Group*

Share findings from small groups, focusing on the mathematics of the experiments. Did your experiments produce results similar to those of the Learner Teachers and the students from Wheeling? Did any of the experiments produce similar graphs? Slopes? Equations? How does the rate of change (slope) show up in each representation?

**20 minutes**

*Whole Group*

#### **View Lesson 2: Charity Walkathons**

While watching the program, consider the following focus questions:

- Solving a system of equations is a standard topic in Algebra I. What does the solution to a system of equations actually tell you?
- Two of the graphs intersect in the Charity Walkathon problem. What does this intersecting point mean in the context of this problem?

### **BEFORE WATCHING THIS PROGRAM ...**

- ▶ Make sure to have copies available of all the lessons in this workshop.
- ▶ Have materials for Lesson 1:
  - Balls
  - Meter sticks
  - Tape measures
  - Circular objects
  - String (optional)
  - Rubber bands
  - Weights
  - Paper clips
  - Paper bridges
  - Pennies
  - Lab sheets.
- ▶ Have materials for Lesson 2:
  - Large chart paper
  - Markers.
- ▶ Have materials for Lesson 3:
  - Graph paper
  - Large chart paper
  - Markers
  - Calculators.

- In the student segment of Charity Walkathons, did Steve understand what it meant when Gilberto's and Alana's graphs intersected?
- In the same student segment, Jake makes this comment about the pledge plans :“I think they all can be right, depends on how far you walk.” Is he correct?
- How is the concept of y-intercept introduced in this problem? In what context?
- What algebra concepts are new to you?
- What concepts do you still have questions about?

**30 minutes**

*Small Groups or with a Partner*

**Read, Do and Discuss**

Read Lesson 2: Charity Walkathons.

Do Lesson 2, including the Launch activities.

Discuss findings, focusing on the above questions.

**20 minutes**

*Whole Group*

**Discuss**

Share findings from small groups, focusing on the mathematics of the lesson.

**20 minutes**

*Whole Group*

**View Lesson 3: Buying T-Shirts**

While watching the program, consider the following focus questions:

- How are slope and y-intercept important in the context of this problem?
- Slope is a ratio sometimes stated as the “change in y over the change in x.” What does this mean for the t-shirt problem?
- The t-shirt problem is open-ended. What does that mean? What are the benefits to giving students open-ended problems?

**20 minutes**

*Small Groups or with a Partner*

**Read, Do and Discuss**

Read Lesson 3: Buying T-Shirts.

Do Lesson 3.

Discuss findings, focusing on the above questions.

**15 minutes**

*Whole Group*

**Discuss**

Share findings from small groups, focusing on the mathematics of the lesson.

**15 minutes**

*Workshop Facilitator/Site Leader*

**Homework Assignment**

- Review Lesson 3.
- Look at the sample student work for Lesson 3 (page 64).
- Review the Launch-Explore-Summarize Teaching Model (page 152).
- Review the Why This Topic Matters section (page 74).
- Use your journal to reflect on the focus questions from this workshop. Describe how these lessons deepened your content knowledge about Patterns & Functions. What did you learn? What else do you need to learn?
- How can you make this topic relevant for your students?
- What questions do you have about the lessons?

# PATTERNS & FUNCTIONS

## WORKSHOP 3: DISCOVERY

### ■ Lesson 1: Predicting from Patterns

#### A. The Big Ideas

##### Purpose of This Lesson

This lesson is designed to help students collect and plot data — and then use the patterns to predict what might happen later on.

##### Mathematical and Problem-Solving Goals

- Understand that experimental data often result in linear relationships.
- Collect data and use patterns in tables and graphs to make predictions.
- Recognize a linear relationship from a table and a graph.

##### Connections to NCTM Standards

- Use patterns to solve mathematical and applied problems.
- Build new mathematical knowledge through work with problems.
- Explore different types of change occurring in discrete patterns, such as proportional and linear changes.
- Examine and interpret relationships between two variables, using tools such as scatter plots and approximate lines of best fit.
- Represent a variety of relations and functions with tables, graphs, verbal rules and, when possible, symbolic rules.
- Model and solve contextualized problems, using various representations (such as graphs and tables) to understand the purpose and utility of each representation.
- Organize and consolidate mathematical thinking to communicate with others.
- Use representations to model and interpret physical, social and mathematical phenomena.
- Develop a repertoire of mathematical representations that can be used purposefully, flexibly and appropriately.
- Create and use representations to organize, record and communicate mathematical ideas.

#### B. The Lesson

##### Recommended Mathematical Background

- Graphing ordered pairs in the first quadrant

##### Materials

- Balls (1 for each Ball Drop Lab, 1 for each Ball Bounce Lab)
- Meter sticks (1 for each Ball Drop Lab, 1 for each Ball Bounce Lab)
- Tape measures (1 for each student in Circle Lab)
- Circular objects (10, such as pizza pan, waste basket, etc., for Circle Lab)
- String (optional)
- Rubber bands (4 for Weights Lab)
- Weights (3–4 bags of circular washers for Weights Lab)
- Paper clips (2–3 for Weights Lab)

### TEACHING TOOLS

- ▶ As you discuss and use this lesson, make sure to take advantage of the Teacher Planning Tools (pages 151-157):
  - Planning a Math Unit: Launch-Explore-Summarize Teaching Model
  - Lesson Planner Template
  - Questions to Stimulate Student Thinking
  - Guidelines for Grouping.
- ▶ Refer to Why This Topic Matters (page 74) to help make this topic relevant to your students.
- ▶ Check out our Web site ([www.learner.org/channel/workshops/missinglink](http://www.learner.org/channel/workshops/missinglink)) for additional tools and resources — and to join The Missing Link online discussion forum.

- Paper bridges (at least 50 for Bridges Lab)
- Pennies (lots — for Bridges Lab)
- Lab sheets (1 per student)

### **Time**

- 80 minutes

### **Lesson Overview**

In this investigation, students divide into small groups and conduct simple experiments, display their data in tables, and draw graphs of the data. In many situations, patterns become apparent only after sufficient data are collected, organized and displayed. Students discover and use patterns in the data to make predictions and recognize linear models from graphs and tables.

### **Launch**

Each group will have a different activity, but the core concepts are the same — see the handouts beginning on page 45 for descriptions of the five lab experiments: Circle, Ball Bounce, Ball Drop, Bridges and Weights. Use the Launch to introduce or refresh students on the concepts of “independent” and “dependent” variables. Help them figure out that the dependent variable (the thing you want to find out) depends on the independent variable (the thing you already know). If students haven’t had experience graphing, do a mini-lesson. Finally, set the time period for collecting data (25–30 minutes) in advance, or students will take longer than necessary.

### **Explore**

The Explore phase of this lesson is a noisy five-ring circus. That’s okay

# EXPLORING FUNCTIONS

Detailed instructions for small groups

## General Instructions

- Select one of the experiments (Circle, Ball Bounce, Ball Drop, Bridges or Weights) and conduct at least 10 trials. Decide how your group will divide the labor.
- Collect the data quickly, so the majority of your time can be spent displaying and analyzing your results.
- Decide which quantity represents the independent variable and which is the dependent variable.
- As you perform each trial, each person should record the data on his or her own lab sheet.
- Graph your results and describe your graph by explaining any patterns or trends present in the data.
- Work together to put your results on large chart paper or transparencies to share with the class.

# CIRCLE LAB

Measure the diameter and the circumference of at least 10 circular objects.

- What variables did you investigate in this experiment? Describe the relationship between the variables.
- Describe the shape of or patterns in your graph.
- Are there patterns that show up in your table? Explain.
- How do the patterns in the table show up in the graph?
- Predict the circumference of a round table with a diameter of 85 centimeters. Explain how you made your prediction. Did you use the table, graph or some other method?
- If you measured the circumference of a tree and found it to be 100 centimeters, what would you expect the diameter to measure? Explain how you made your prediction. Did you use the table, graph or some other method?

# BALL BOUNCE LAB

Drop a ball from a measured height, and count the number of times it bounces. Use 10 different drop heights. Sight the drop height using the bottom of the ball.

- What variables did you investigate in this experiment? Describe the relationship between the variables.
- Describe the shape of or patterns in your graph.
- Are there patterns that show up in your table? Explain.
- How do the patterns in the table show up in the graph?
- Predict the number of times a ball would bounce if it dropped from a height of 2 meters. Explain how you made your prediction. Did you use the table, graph or some other method?
- A ball bounced 12 times after it was dropped. From what height was it dropped? Explain how you made your prediction. Did you use the table, graph or some other method?

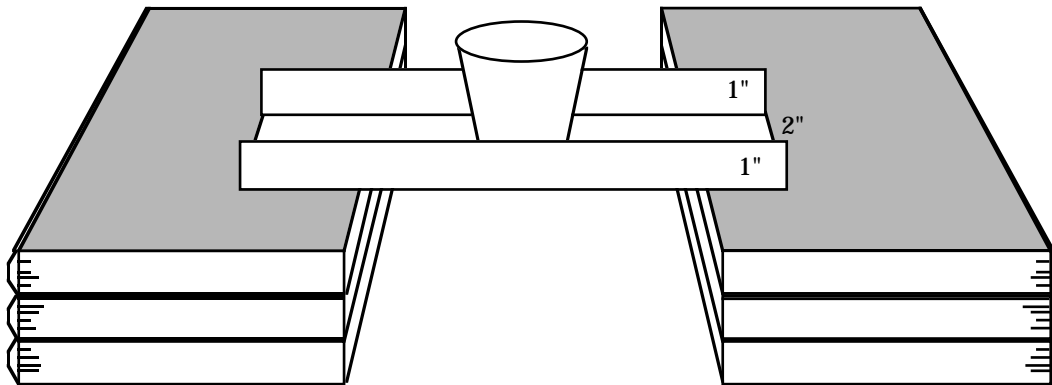
# BALL DROP LAB

Drop a ball from a measured height, and measure how high it bounces on the first bounce. Sight the drop height and bounce height using the bottom of the ball. Use 10 different drop heights.

- What variables did you investigate in this experiment? Describe the relationship between the variables.
- Describe the shape of or patterns in your graph.
- Are there patterns that show up in your table? Explain.
- How do the patterns in the table show up in the graph?
- Predict the height a ball would bounce if it dropped from a height of 2 meters. Explain how you made your prediction. Did you use the table, graph or some other method?
- Predict the drop height needed for a bounce height of 2 meters. Explain how you made your prediction. Did you use the table, graph or some other method?

# BRIDGES LAB

Test the breaking weight of different thicknesses of paper bridges. To make a “bridge,” fold up 1" on each long side of 11" x 4" paper strips. Then suspend the bridge between two equal stacks of books. The bridge should overlap each stack by about 1". Put pennies one at a time into a paper cup placed in the middle of the bridge until the bridge collapses. Record the number of pennies as the “breaking weight” of the bridge. Then put two new strips of paper together and fold to make a new bridge. Repeat the experiment by adding pennies to the cup to find the breaking weight of a “two-thickness” bridge. Continue by making bridges of three thicknesses, four thicknesses and on up to eight thicknesses. With each new bridge, keep track of the number of pennies it takes to make the bridge collapse.



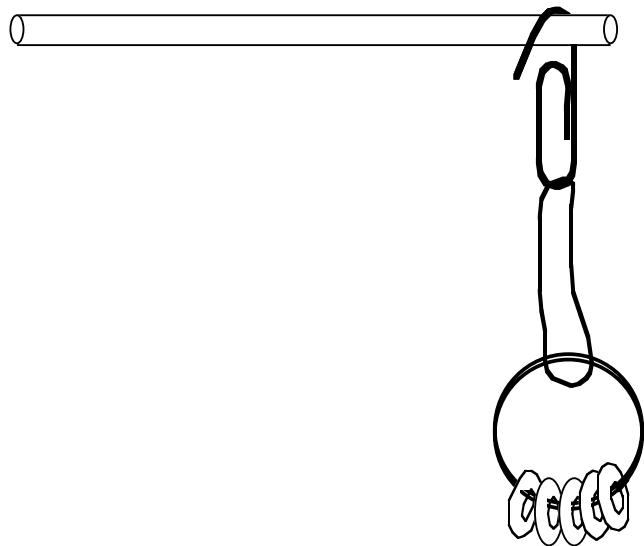
*Continued on page 50*

- What variables did you investigate in this experiment? Describe the relationship between the variables.
- Describe the shape of or patterns in your graph.
- Are there patterns that show up in your table? Explain.
- How do the patterns in the table show up in the graph?
- Predict the breaking weight of a bridge 20 layers thick. Explain how you made your prediction. Did you use the table, graph or some other method?
- If it took 8 pennies to break a bridge, what would you predict for the thickness of the bridge? Explain how you made your prediction. Did you use the table, graph or some other method?

# WEIGHTS LAB

Hang weights on a paper clip suspended from a rubber band and measure the stretch of the rubber band.

- What variables did you investigate in this experiment? Describe the relationship between the variables.
- Describe the shape of or patterns in your graph.
- Are there patterns that show up in your table? Explain.
- How do the patterns in the table show up in the graph?
- Suppose that the rubber band could not break. Predict the number of weights it would take to stretch the rubber band to a length of 50 centimeters. Explain how you made your prediction. Did you use the table, graph or some other method?
- If you could place 100 weights on the paper clip, predict how far the rubber band would stretch. Explain how you made your prediction. Did you use the table, graph or some other method?



## ■ Lesson 2: Charity Walkathons

### A. The Big Ideas

#### Purpose of This Lesson

This problem gives students an opportunity to think about rate in the form of payment per mile for a walkathon. The focus is on how different rates affect the various representations of graphs, tables and equations, building on observations made and lessons learned in the previous lesson.

#### Mathematical and Problem-Solving Goals

- Recognize linear functions from tables and graphs.
- Understand how the rate of change between two variables is communicated in the graphs and tables.
- Recognize that a change in rate will affect the steepness of a line.
- Interpret the meaning of the coefficient of the  $x$  and the  $y$ -intercept of a graph in the equation  $y = mx + b$ .

#### Connections to NCTM Standards

- Use patterns to solve mathematical and applied problems.
- Model and solve contextualized problems, using various representations (such as graphs and tables) to understand the purpose and utility of each representation.
- Develop an initial understanding of rate of change, with emphasis on the connections of slope of a line, constant rate of change and their meaning in context.
- Analyze, create and generalize numeric and visual patterns, paying particular attention to patterns that have a recursive nature.
- Explore relationships between symbolic expressions and graphs, paying particular attention to the horizontal and vertical intercepts, points of intersection, and slope (for linear relations).
- Recognize, use and learn about mathematics in contexts outside of mathematics.
- Use representations to model and interpret physical, social and mathematical phenomena.

### B. The Lesson

#### Recommended Mathematical Background

- Graphing ordered pairs in the first quadrant

#### Materials

- Large chart paper
- Markers

#### Time

- 60 minutes

## TEACHING TOOLS

- ▶ As you discuss and use this lesson, make sure to take advantage of the Teacher Planning Tools (pages 151-157):
  - Planning a Math Unit: Launch-Explore-Summarize Teaching Model
  - Lesson Planner Template
  - Questions to Stimulate Student Thinking
  - Guidelines for Grouping.
- ▶ Refer to Why This Topic Matters (page 74) to help make this topic relevant to your students.
- ▶ Check out our Web site ([www.learner.org/channel/workshops/missinglink](http://www.learner.org/channel/workshops/missinglink)) for additional tools and resources — and to join The Missing Link online discussion forum.

### **Lesson Overview**

In this investigation, students first do a short lesson on walking rates, and then in the main lesson they look at suggestions classmates have made for setting pledge amounts for a walkathon. The charity walkathon pledge plans involve the amount donors should contribute, based on the rate per mile. The students explore three different pledge situations by setting up graphs, tables and equations to model the three different scenarios. After comparing the situations, students recommend which of the three pledge plans the class should select and use. The pledge plans allow students to connect the rate of change to the concept of slope of a line and to see how that rate of change appears in a table and equation. Students also are introduced to a nonzero y-intercept. And they see how the y-intercept appears in the table, graph and equation. Most important, students identify both the rate of change and y-intercept and what they mean in the context of the problem.

### **Launch\***

There are a lot of different concepts coming into play in this lesson; use the Launch to make sure that all of your students are clear on the big ideas. Begin by doing a mini-lesson on walking rates.

### *Option 1:*

Begin by discussing what a walking rate is and have students predict how many meters per second they think they could walk. You may even ask a student to demonstrate and have the class calculate his or her walking rate. Then give students this problem and have them work on it in pairs or individually. Take time to summarize their results, specifically addressing how the walking rate affects the three different representations.

In gym class, students found their walking rates. How does walking rate affect the amount of time it takes students to walk certain distances? Below are three students' results. Make a table and graph of the time and distance data for the three students and then write an equation that gives the relationship between time and distance walked. Let  $d$  = distance in meters and  $t$  = time in seconds.

How does walking rate affect the data in the table? In the graph? In the equation?

Miles	Terry 1 meter per second	Jade 2 meters per second	Jerome 2.5 meters per second
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

### *Option 2:*

Before the class begins, measure off a distance of 10 meters. Then, as in Option 1, discuss what a walking rate is and how it can be calculated. Select three students, one to walk the 10-meter distance slowly, another to walk it at a normal pace and a third to walk the distance as quickly as possible. Time each student, and as a class calculate the different walking rates of each student in meters per second. Complete the problem as in Option 1 by having students make a table, graph and equation for each student's data.

Then introduce the Charity Walkathons problem. Make sure students understand the two variables in this problem are distance walked and money pledged.

### **Explore**

This is both an independent and a group activity. Have each student produce his or her own table and graph and then discuss the findings with their seatmates. A few tips for getting them started: When graphing the data, have students use a different color for each walker; encourage students to write the relationship between the two variables first in words, then in symbolic form; and make sure students see that the best plan depends on the number of miles walked.

As always, your job during this part of the lesson is to observe. Avoid teaching as you circulate among the groups, but rather, suggest activities to make the data easier to understand for those who are stuck, and make the lesson more challenging for those who get it. Expect students to have different-looking graphs because they will choose different scales for the y-axis. Likewise, students will give different answers when asked which representation (table, graph or equation) most helped them see the situation. Bring all these varied concepts and ideas to your Summarize and present them to the class.

### **Summarize**

Have students report their findings. Make sure students understand the core concepts of the lesson:

- in linear relationships, both variables change at a constant rate
- the rate of change affects the steepness of a line
- linear relationships can be displayed in tables, graphs and equations
- the y-intercept is recognized easily on a graph

Make sure that in your Summarize you identify exactly *when* each plan would be best. Note: Leanne's plan will never be better than Gilberto's. At what point will Leanne's be better than Alana's? Be sure your students have a clear understanding of the benefits of each representation (table, graph and equation).

Part of the purpose of the Summarize is to allow you to assess how well your students are progressing toward the goals of the lesson. Use the discussion to help you determine whether additional teaching and/or additional exploration by students is needed before they go on to Lesson 3.

### **Additional Notes**

- Encourage students to make the connection between the coefficient of the x and the steepness of the line. We want them to see that the larger the coefficient, the steeper the line on the graph. Don't be too quick to have students eliminate coefficients of 1, as in  $d = 1t$  for Terry's walking rate. The 1 helps them connect the rate to the slope. The equation for Alana's plan ( $y = 5 + 0.5m$ ) is a perfect time to begin talking about the formal y-intercept form of an equation ( $y = mx + b$ ). Do not expect students to memorize this formula at this time though; simply introduce the terms of coefficient, y-intercept and slope.

\*Source for Launch section of lesson: *Connected Mathematics Project — Moving Straight Ahead*

# CHARITY WALKATHONS

Ms. Chang's class decides to participate in a walkathon to raise money for a local hospital. Each participant in the walkathon must find sponsors to pledge a certain amount of money for each mile the participant walks.

Ms. Chang says that some sponsors might ask the students to suggest a pledge amount. The class wants to agree on how much they will ask for. Leanne says that \$1 per mile would be appropriate. Gilberto says that \$2 per mile would be better because it would bring in more money. Alana points out that, if they ask for too much money, not as many people will want to be sponsors. She suggests that they ask each sponsor for a \$5 donation plus \$0.50 per mile.

- Make a table and graph of each of the pledge plans and then write an equation that can be used to calculate the money a sponsor owes, given the total distance the student walks.
- Compare the plans and write a convincing argument for the pledge plan you would recommend that the class adopt.

Source: *Connected Mathematics Project — Moving Straight Ahead*

# CHARITY WALKATHONS

Name \_\_\_\_\_

Distance Miles	Money Owed		
	Leanne's Plan	Gilberto's Plan	Alana's Plan
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

- What effect does increasing the amount pledged per mile have on the table? On the graph? On the equation?
- If a student walks eight miles in the walkathon, how much would a sponsor owe under each pledge plan? Explain how you got your answer.
- For a sponsor to owe \$10, how many miles would the student have to walk under each pledge plan? Explain how you got your answer.
- Alana suggested that each sponsor make a \$5 donation and then pledge \$0.50 per mile. How is this fixed \$5 donation represented in the table? In the graph? In the equation?

Source: *Connected Mathematics Project — Moving Straight Ahead*

## ■ Lesson 3: Buying T-Shirts

### A. The Big Ideas

#### Purpose of This Lesson

Now that the students have had some experience using graphs and tables to analyze data, they're ready to explore a third representation — the equation.

#### Mathematical and Problem-Solving Goals

- Connect solutions in graphs and tables to solutions of equations.
- Find a solution common to two equations by graphing.
- Understand how the  $y$ -intercept appears in tables and equations.
- Understand how the rate of change appears in equations and affects the graph of a line.

#### Connections to NCTM Standards

- Use patterns to solve mathematical and applied problems.
- Model and solve contextualized problems, using various representations (such as graphs and tables) to understand the purpose and utility of each representation.
- Explore relationships between symbolic expressions and graphs, paying particular attention to the horizontal and vertical intercepts, points of intersection, and slope (for linear relations).
- Use graphs, tables and equations to solve a system of equations.

### B. The Lesson

#### Recommended Mathematical Background

- Graphing ordered pairs in the first quadrant

#### Materials

- Graph paper
- Large chart paper
- Markers
- Calculators

#### Time

- 60–80 minutes

#### Lesson Overview

In this investigation, students use their knowledge of functions to decide which t-shirt company the Student Council should hire to make t-shirts for the school. Various representations are used to try to find a common solution to two different equations. Students find their answer graphically and then interpret it in the context of the problem. Finally, students provide their classmates with convincing arguments that support their company choice.

## TEACHING TOOLS

- ▶ As you discuss and use this lesson, make sure to take advantage of the Teacher Planning Tools (pages 151-157):
  - Planning a Math Unit: Launch-Explore-Summarize Teaching Model
  - Lesson Planner Template
  - Questions to Stimulate Student Thinking
  - Guidelines for Grouping.
- ▶ Refer to Why This Topic Matters (page 74) to help make this topic relevant to your students.
- ▶ Check out our Web site ([www.learner.org/channel/workshops/missinglink](http://www.learner.org/channel/workshops/missinglink)) for additional tools and resources — and to join The Missing Link online discussion forum.

### **Launch**

Students are given two bids for t-shirts, All T's and Tees and More. As in Charity Walkathons, they will present their data in three different formats: table, graph and equation. This is a good lesson to use a “think, pair, share” strategy — have students work independently for a while, then discuss and solve the problem with a partner, and then share their solution and strategy with the larger group.

Urge students to plan in advance which kind of representation they'll use to solve the problem. Don't be surprised if most use tables and charts, not equations. As you did in the Predicting From Patterns lesson, however, don't let their predictions influence the actual outcome — make sure they use the math to find the answer. As with Charity Walkathons, remind students that the “right” answer depends on the independent variable — in this case, how many t-shirts they buy.

Finally, appoint a timekeeper for your lesson. He or she can notify you when the class is almost over so you have time to bring closure to your lesson.

### **Explore**

Circulate around the classroom at least twice — once as students work independently and once after they pair up. Keep an eye out for students simplifying the exercise too much; if they just use a table to present their solution, encourage them to try a graph also. Have a list of questions ready to prod the slower thinkers and challenge the quicker ones. And encourage all students to vocalize the connections among the table, the chart and the equation. The Learner Teachers agreed that this was one of the most powerful parts of the lesson and yet the hardest to teach.

### **Summarize**

Have students explain their findings. Make sure to clarify for your students the core concepts of this lesson:

- the solution to an equation is a point on a graph
- when lines intersect, the point of intersection solves both equations.

In the context of this problem, this point of intersection is where the number of shirts purchased costs the same amount for both companies.

Don't shortchange the Summarize. The students seen in the classroom examples from Wheeling, Ill., needed additional time to talk about the three different representations. They didn't fully develop the connections among the graph, table and equation. Guide your students to make these connections and to find the same information on all three representations.

Part of the purpose of the Summarize is to allow you to assess how well your students are progressing toward the goals of the lesson. Use the discussion to help you determine whether additional teaching and/or additional exploration by students is needed before they go on to the next topic.

### **Additional Notes**

- As an extension, you might have your students plot their data on a software spreadsheet and then use Powerpoint to present their findings to the class.

# WHICH T-SHIRT COMPANY?

Suppose the Student Council from your school is planning to sell t-shirts with the school emblem to raise money for the upcoming dance. Members of the Student Council received bids from two companies.

ALL T'S charges \$100 plus \$3 per shirt

TEES AND MORE charges \$5 per shirt

You must prepare a presentation to give to the entire student body, recommending which t-shirt company the school should use. Your presentation must be explained fully with mathematical evidence that supports your choice.

Things You Might Consider:

- A. Which company would help keep the cost to a minimum?
- B. How many students might purchase shirts?
- C. What equations could represent the costs with two companies?
- D. What would the graphs look like that represent the two companies?
- E. How can data be displayed in tables that would show differences in the two companies?

Source: Adapted from *Connected Mathematics Project — Moving Straight Ahead*