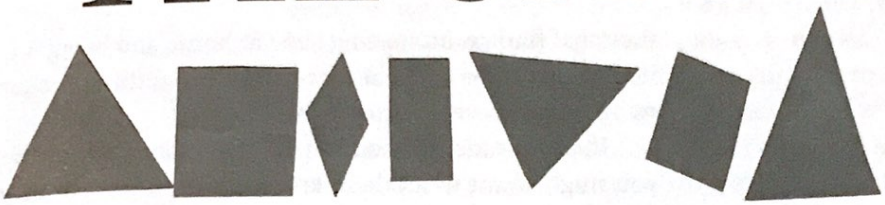
CHAPTER 6

THE SHOE



You *know* your students will be prepared for these activities. As long as they arrive at school wearing shoes, they're ready to go. Shoes are very basic objects, literally grounding us and connecting us to the earth. They are essential to most of our daily lives. Although they are a fundamental part of our garb, shoes provide an amazing variety of styles, colors, purposes, and components. This variety gives teachers a myriad of ways to integrate shoes into meaningful, creative, engaging activities.

Depending on your geographic region and the season, the types of shoes your students wear will vary. Keep this in mind as you plan your lessons. We live in Southern California, so on any given day most of our elementary students are wearing some sort of sneaker or tennis shoe. If your school has a prescribed shoe as part of the school uniform or you find there isn't much variation in the shoes in your classroom, you can ask students to bring a shoe from home that they will use for the sequence of lessons. The shoe from home doesn't have to be theirs; they can borrow one from a family member. You can even provide a prompt that challenges

ACTIVITY	GRADES	NUMBER AND OPERATIONS	ALGEBRA	GEOMETRY	MEASUREMENT	DATA ANALYSIS AND PROBABILITY
All About My Shoe	K–2, 3–5	✓			✓	
Shoe Comparing	K–2		✓			
Shoe Sorting	K–2		✓			
Shoe Graphing	K–2, 3–5					✓
Masking Tape Shoes	3–5			✓		
Shoe Rubbings	3–5		✓			

them to "find an interesting shoe at home and bring it to class. Make sure it's okay with the adult in charge. You will return the shoe unharmed when we're finished with our activities."

If your students need to take their shoes off for the activities you do, you might want to let them know ahead of time so they can choose shoes (and socks) accordingly. Also consider the weather. You might prefer to have your students keep their shoes on if sweaty socks or bare feet might interfere with the focus. We think shoes are the perfect context for integrating math and visual arts. We encourage you to put on your sneakers and jump in.

THE SHOE AND THE MATHEMATICS

Why are shoes so perfect for integrating math and visual arts? Well, first of all, shoe designers consider all the elements of visual arts when creating their products: color, pattern, line, and balance all play into how a shoe looks and who will find it appealing.

Shoes provide built-in measurement opportunities. Students get new shoes based on size and often must have their feet measured to figure out what size they are. Plus, shoes are fabulous, curved, three-dimensional objects with both positive and negative space to measure.

In addition to providing measurement opportunities, shoes have visual and numerical patterns that lend themselves nicely to graphing and algebra. A good shoe can take you a long way.

THE SHOE AND THE ART CONNECTIONS

The shoe as an art object has a long cultural history that is rich in metaphor. One can trace style and fashion, and social, economic, and regional cultural connections through shoes. Shoes are used as a metaphor to reflect our experience in common sayings such as "Walk a mile in my shoes" or "Those will be big shoes to fill." In the arts, shoes can act as a

stand-in for people in stories about human events. Artists have employed the shoe to represent migration, personal experience, and social status. Visual artists and historians have used shoes to help us visualize the loss of human life in genocide and human rights abuses. We can imagine a wide range of human experience just by looking at different kinds of shoes (think of clown shoes, moccasins, Japanese wooden slats, and so on).

In the early 1970s contemporary artist Eleanor Antin created a series of photographs on postcards titled *100 Boots* that shows a group of one hundred boots in various locations. The postcards acted as both the art material and documentation of the project. She has referred to the series as a "pictorial novel" that arrived in the mail unannounced to thousands of people in different parts of the world.

Elizabeth Murray, an artist known for her whimsical, colorful, and dimensional paintings (paintings with pieces that protrude from the wall), was commissioned in 1996 to create a site-specific sculpture for the renowned Stuart Collection on the campus of University of California–San Diego. In a surrounding of eucalyptus trees she placed a giant cartoonish and festive *Red Shoe* that one can climb onto and inside. Scattered around the shoe, which looks as if it just walked into its place, are jewel-like sculptural objects.

Robert Rauschenberg is considered one of the most important American artists of the twentieth century. He is known for his early use of unlikely materials and found objects such as shoes, tennis balls, taxidermy,

and paint to create sculptures that he called "combines." Causing quite a stir in the art world in the early 1960s, he pioneered new techniques in printmaking and collage with low-tech processes such as simple rubbings, or printing from tire treads. He continued to have a long and influential career in the arts until his death in 2008.

René Magritte, a Belgian Surrealist artist, painted a pair of boots that morph into human feet with laces. There are sketches, photographs, and paintings by artists throughout history who have used shoes as a subject. Shoes from every culture and time period can be found in collections in the great museums around the world.

Shoe Art Vocabulary: collage, dimensional paintings, printing, rubbing, site-specific sculpture, Surrealism

THE SHOE LESSONS

LESSON All About My Shoe

Grade Level: K–2, 3–5

Math Content Area: Number and Operations, Measurement

Math Overview: In *All About My Shoe* students investigate the physical features of their shoes and record details about shoe measurements. Students' estimates allow them to compare quantities and do some mental computation.

Guiding Questions:

K–2 Number and Operations

What are some ways to count and find out how many?

What tools can help with counting and finding out how much or how many?

K–2 Measurement

What parts of the shoe can we measure?

How can we measure different parts of a shoe?

3–5 Number and Operations

How can you use addition or multiplication to find the answer?

What estimation strategies might help you?

3–5 Measurement

What are the different parts of a shoe that you can measure? What tools and which units could you use to measure the different shoe parts?

What are some strategies for estimating measurements?

Vocabulary: length, width, height, volume, surface, area, pattern, texture, shape, color, estimate

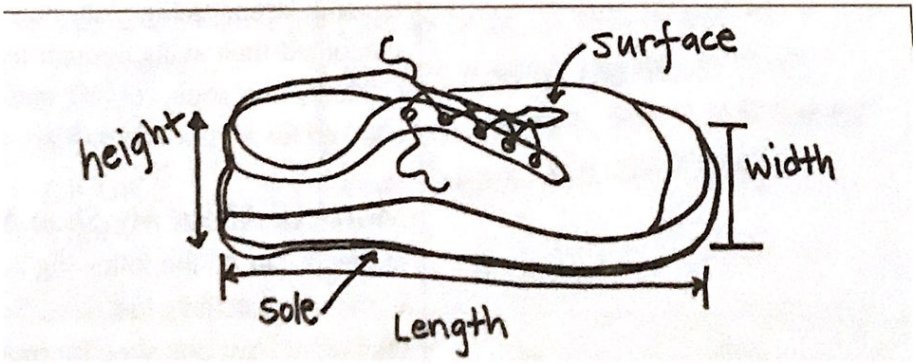
rulers, cubes, pencils, markers and/or colored pencils, 9-by-12-inch white construction paper, *All About My Shoe* recording sheets (see appendix and CD), scissors

Believe it or not, we conducted this activity with three classes combined, totaling around eighty students. To add to the challenge the grade levels were first, third, and fifth. We had the students sit at tables with a mix of grade levels, knowing the younger students would require more support and the older students would benefit from the opportunity to mentor their younger buddies. The students from Fay Elementary in San Diego visited the UC–San Diego campus and stopped by Caren's classroom for an hour to experience "a real college class." Knowing they'd all be wearing shoes, we took the opportunity to have them explore and investigate. Because we had a limited time frame, we barreled through a sequence of activities. You most likely will want to slow down and conduct these activities over several days. They're rich in both the mathematics and the visual arts connections.

To begin the lesson we asked the students how artists get their ideas. Because the grade range was vast and there were many English language learners in the group, we had them first talk briefly at their tables, both to generate ideas and to produce the language necessary to share with the whole group. When we asked the students to share some of the ideas that arose at their tables, they had a range of thoughtful responses:

Things that happen in their lives
How they express themselves
From other pictures
Their dreams
Their imagination
Museums
Using their five senses
Memories
School and learning about stuff

From the general discussion about artists' ideas we transitioned specifically to shoes. We asked the students to talk to a partner about what they noticed about their shoes. The goals for this partner talk were to help students notice the various features of their shoes and to produce the vocabulary they would need as the lesson progressed. As we conducted a brief whole-class discussion, we drew and labeled a shoe on the whiteboard. This visual reference gave students further access to the vocabulary.



The next step was to show a brief slide show of different styles of shoes and different uses of shoes in art (such as shoe buildings, shoe cars, shoe chandeliers, and shoe bicycles). Students delighted in the shoe show. They oohed and aahed over every image. Something special happens when people see a common object presented in a unique and creative way. Students loved seeing shoes in contexts that weren't ordinarily "shoeish." Telling them it was their turn to be shoe artists, we let them know it was time for them to work on their own shoes.

"The first thing artists do is notice," we explained. "So we want you to notice and get to know your shoe in ways you probably haven't before. We have a recording sheet to help you keep track of all the things you learn about your shoe."

We showed them the *All About My Shoe* recording sheet and referred to the picture on the whiteboard to help them remember the names of the parts of the shoe and measurement terms.

The shoe exploration had three parts. First, the students estimated the measurements for different components of their shoes such as length, width, height, volume, surface area, and area of the sole. Then they did the actual measuring with the rulers and cubes we provided. (With older students and more time you can have students find the difference between the estimate and actual measurement.)

The next step involved students using their observation skills and vocabulary to describe their shoes. We prompted students to talk at their tables about the lines, shapes, colors, patterns, and textures they saw. They used their recording sheets to document what they noticed. We provided sentence frames on the recording sheet to assist the younger students and English language learners.

Finally students traced the sole of one of their shoes on a piece of 9-by-12-inch construction paper. They used this shoe outline to redesign their shoe, using some of the ideas presented earlier in the sequence. Markers and colored pencils gave students ways to create new patterns, shapes, and themes for their shoe design. These colorful, imaginative shoe shapes can be cut out and used for sorting, comparing, and graphing activities later. (See activities that follow.) They can also be posted along a wall as a border or used as nonverbal signage to mark a path.

The fact that first, third, and fifth graders all remained engaged and enthused throughout the activities speaks to the power of teaching mathematics through the visual arts. Some of the estimating and measuring activities served as practice for the older students, but it worked equally well as introduction and exposure for the younger ones. Plus, the younger students benefited from seeing older students as role models, and the older students reinforced their skills through teaching them to their younger tablemates. Certainly the shoe context and the hands-on approach to the activities allowed for all students to learn at their own level.

More *All About My Shoe* Activities

Students can do the following activities with the shoe cutouts they created in the initial activity just described or with their actual shoes. (They need to take off at least one shoe for most of these activities.)

Shoe Comparing

Grade Level: K–2

Math Content Area: Algebra

Math Overview: *Shoe Comparing* gives students experience with identifying and describing attributes. They consider such mathematical features as size, shape, and weight. Use of descriptive and mathematical language develops students' abilities to communicate mathematically.

Guiding Questions:
What's the same about these shoes?
How are these shoes different?

Vocabulary: same, different, sort, color, pattern, line, shape, texture

Materials: shoe cutouts or actual shoes

Elisabeth Frausto let us try the following two activities with her kindergartners. Have students sit on the rug in a circle or in some other configuration that allows for easy viewing of a set of objects. Take six to ten shoes and have students notice and describe their different components. Students may remark on the color, style, size, laces, or any number of details. Encourage them to use the vocabulary generated in the *All About My Shoe* lesson. Have them identify ways some shoes are the same and different. Pick two shoes to model as an example. Provide sentence frames: "These shoes are the same because they both have _____." "These shoes are different because one _____ and the other _____."

Partners can then go back to their seats with two shoes to compare. They can discuss the similarities and differences and record their ideas on a T-table.

SAME	DIFFERENT
Laces Line patterns 2 colors bLue circles Dirty	one has black, one has no black one is size 3, one is size 5 one has a star, one has no stars one is a sandal, one is A sneaker the shapes are different

Shoe Sorting

Grade Level: K–2

Math Content Area: Algebra

Math Overview: *Shoe Sorting* allows students to group and classify shoes based on different attributes. This activity lays the groundwork for later algebraic thinking by having students seek patterns and consider and describe features and relationships.

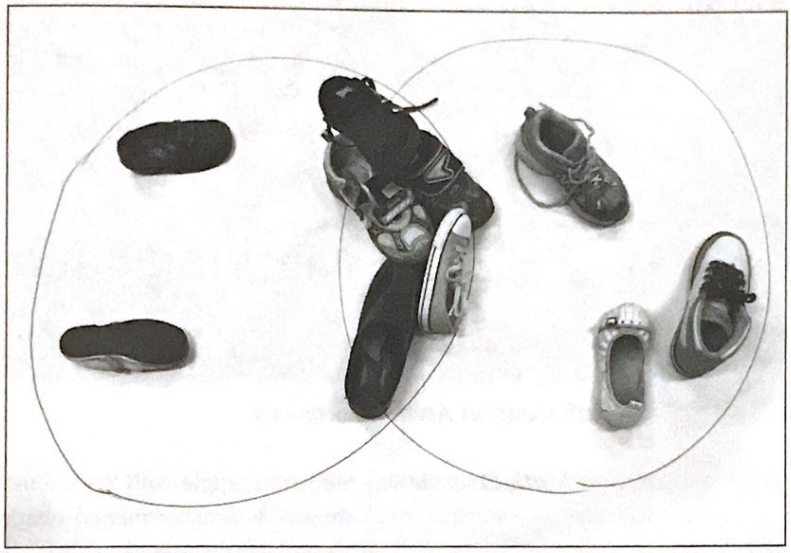
Guiding Questions: How can we group these shoes so they fit different criteria?
How can we organize the shoes to show which criteria they fit?

Vocabulary: same, different, Venn diagram, circle, texture, shape, color

Materials: shoe cutouts or actual shoes, large piece of butcher paper with a large circle drawn on it slightly to one side

This activity builds on the *Shoe Comparing* experience. Have students sit in a circle with eight to ten shoes in the middle. Tell the students you are thinking of a secret category and are going to show them which shoes fit the category and which shoes don't. Their job is to guess the category. You might start with a simple category such as "has laces." As you sort the shoes, say to the students, "This shoe fits my secret category" and put it within the circle on the butcher paper or "This shoe doesn't fit my category" as you move the shoe onto the butcher paper outside the circle.

Encourage students to continue to use the vocabulary they've been using in the *All About My Shoe* lessons. Let students try to guess your secret category. If students are ready, they can generate their own categories, sort the shoes, and have the class try to guess their categories. You can also extend this activity by sorting shoes with a two-variable Venn diagram. Simply add another large overlapping circle to your butcher paper. Each circle represents a category (for example, "has laces," "has blue on it"), and shoes that fit both categories go in the middle of the two circles.



Shoe Graphing

Grade Level: K–2, 3–5

Math Content Area: Data Analysis and Probability

Math Overview: *Shoe Graphing* gives students an opportunity to organize data visually in a graph format. Students apply the vocabulary and concepts acquired through *Shoe Comparing* and *Shoe Sorting* to create shoe graphs that display shoes according to predetermined categories.

Guiding Questions:

K–2

Can we make a graph that tells how many shoes fit a certain category?

3–5

What questions can we ask about our shoes?

What types of graphs can help display information about the shoes in our classroom?

How can we use what we know about the shoes in our classroom to make predictions about shoes in other classrooms?

Vocabulary: graph, likely, unlikely, color, texture, pattern

Materials: shoe cutouts or actual shoes, butcher paper or graph paper, markers

This activity naturally extends from the *Shoe Sorting* activity. Once students proficiently identify different shoe attributes, they can create graphs to represent these attributes. Students can use Venn diagrams to represent overlapping attributes or bar graphs to represent singular features of a shoe. (How many lace holes does your shoe have? Does your shoe have stripes?)

Younger students benefit from seeing how data can be displayed in a variety of ways. Challenge older students to predict what the data might show in the class next door or even schoolwide: "It is likely that the shoes next door _____." "It is unlikely that the shoes next door _____." Older students can also collect and graph data about shoes in their classroom to hypothesize the features of "the average shoe" in their class.

LESSON Masking Tape Shoes

Grade Level: 3–5

Math Content Areas: Geometry

Math Overview: Students grapple with key geometry concepts while creating masking tape shoes. They make mental images and consider an object from multiple perspectives. Students analyze the geometric properties of their shoes and break the three-dimensional shoe into two-dimensional components. From there they use the two-dimensional model to build a three-dimensional object.

Guiding Questions:

What are the different pieces of a shoe? Describe their shapes and relative size.

What new shapes do the pieces form when combined?

How do two-dimensional pieces combine to form a three-dimensional object?

Vocabulary: deconstruct, plan view, other views, visual weight, perspective, structure, construction, problem solving, two-dimensional, three-dimensional, plane

Materials: shoe, paper, pencil, one roll of masking tape per student, tools such as paper clips, pens, toothpicks

This activity really delivers. Kristin Komatsubara found great success with her intermediate-grade students. She started by having students view and sketch their shoes from a variety of perspectives: front, side, bird's-eye, and plan view. Then she had the students visually deconstruct their shoe, looking carefully at all its component parts. She prompted them by having them imagine a shoe factory. She asked students to think about the different pieces of the shoe that have to be put together. Then she had them do quick sketches of all the different parts of the shoe they could identify.

She pointed out that in these activities students represented a three-dimensional object (the shoe) on a two-dimensional plane (the paper).

Once students spent time thinking about the parts of the shoe and how shoes are put together, they were ready to construct their own shoe. The students' task was to make an actual-sized, detailed model of their shoe using only masking tape. Although it seemed impossible at first, Kristin reassured them of the viability of the project by showing some photos of other masking tape shoes. She pointed out that the successful tape shoes had "visual weight." Even though they consisted only of tape, they looked sturdy and seemed to have the weight of an actual shoe.

Kristin gave the students some time to hypothesize about and discuss the potential effectiveness of different techniques and tools. Then she brainstormed with students about possible approaches to the job. She gave them an opportunity to get started during class. She stopped them after ten or fifteen minutes to discuss how it was going, what was working, and how they planned to continue the work. Kristin gave them a due date for the final products. The students completed the project either at home or during independent work time. When the shoes were finished, the class had a gallery walk to appreciate each other's work. Afterward, Kristin displayed the tape shoes prominently outside her classroom. They impressed all who viewed them and represented a true problem-solving experience.

LESSON

Shoe Rubbings

Grade Level: 3–5

Math Content Area: Algebra

Math Overview: The *Shoe Rubbings* activity gives students multiple ways to represent algebraic data. From a concrete model, they find patterns and generate algebraic equations. They encounter geometric, graphic, and numeric representations of algebraic patterns.

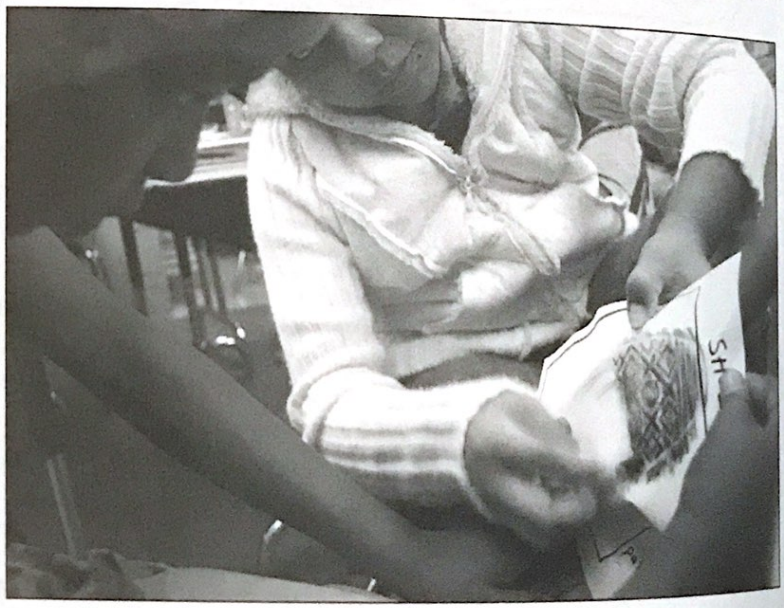
Guiding Questions:

What patterns do you see?
How can the pattern be described with words, numbers, graphs, or equations?
Can you predict what the pattern would be on a larger shoe?

Vocabulary: line, diagonal, vertical, horizontal, perpendicular, angle, shape, intersection, pattern, texture, prediction, variable, repeating pattern, growth pattern, radial

Materials: shoe, crayons, *Shoe Rubbing* recording sheet (see appendix and CD)

This activity focuses on the patterns on the sole of the shoe. When we did it with Tina Rasori's fifth graders, we took a risk and hoped there would be enough variety and some tread patterns with algebraic implications. If you don't want to risk it, you might have each student bring in a shoe in advance so you can see what you're going to end up with. You need sole treads with either obvious repeating (e.g., square, triangle, square, triangle, etc.) or growth patterns (e.g., one square, two squares, three squares, etc.). If you're not thrilled with the selection, you can bring in one or two of your own shoes to make sure you have at least one example of a growth pattern on a shoe sole.



We began the session by telling students we were going to use an object that would connect math and art. We gave them three clues and told them to talk to a partner about what they thought this object might be.

It's something you wear.
It protects part of your body.
It goes over your sock.

It wasn't the most challenging riddle, but the students enjoyed the format and the opportunity to show how smart they were in solving the puzzle.

Because we knew the students were starting a unit on algebra, we mentioned how patterns play an important role in algebra. Then we asked the students to talk to a partner about patterns on their shoes. They generated a long list of words describing their shoes' patterns and attributes. We wrote the list on the board so students would have access to the vocabulary and ideas when they returned to their seats. The board was filled with words such as *bumpy, oval, square, line, hexagon, wavy, slanted, diamond,* and many more. This visual reference proved very helpful, especially for the many English language learners in the class.

We then pointed to the bottom of a sample shoe and told the class that we were focusing on the bottom or sole today. We modeled how to capture an impression of the sole with a crayon rubbing. To start we modeled capturing the imprint of the sole of my shoe by placing a piece of paper over it and rubbing across the paper with a crayon. The students knew the technique from detective and forensic TV shows, and it's the same technique that artist Robert Rauschenberg used.

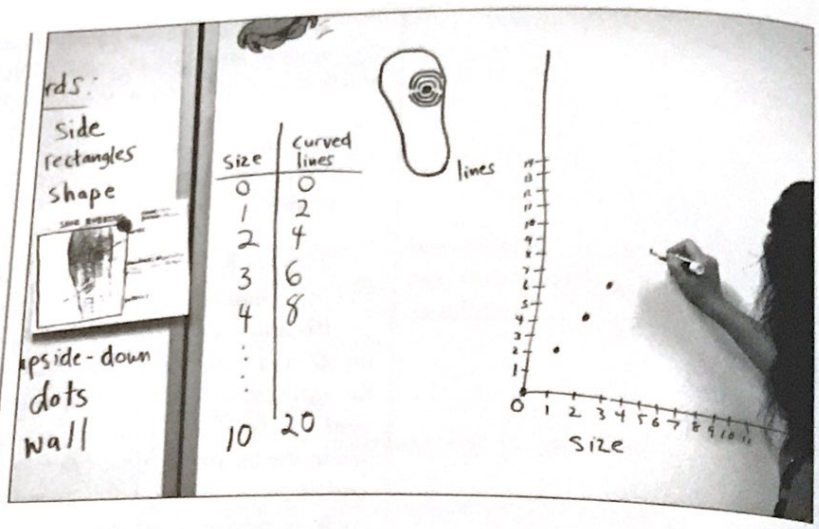
After we got the rubbed image of the shoe sole, we reviewed relevant vocabulary and recorded it on the board for students' reference. We taped the shoe rubbing on the board and had students describe numbers and patterns that they noticed. Amazingly, Kevin immediately saw a number pattern (two rectangles, two rectangles, four rectangles, two, two, four . . .). The class generated a lot of words, which we added to the list on the board.

Then we gave the students a job. We posted the directions on the board since it was a multistep assignment:

Your Job
Work with a partner at your table.
Help each other make a shoe rubbing on your recording sheets.
Describe the shoe rubbing with words and numbers.
Tell about any patterns you notice.
Record your work on the *Shoe Rubbings* sheet.

Students went back to their tables to capture their own shoe rubbings and generate words, numbers, and patterns. They worked in pairs to capture a crayon imprint of the sole of their shoes on a *Shoe Rubbing* recording sheet. Students used math and art vocabulary to describe the patterns and shapes they saw on their shoe rubbings.

As the students worked, we circulated, checking on their progress and prompting them to record as much as possible on their papers. Our other



agenda item was to find a shoe pattern that could be modeled algebraically. Thankfully, we saw Katie's and realized the growth pattern of curved lines would fit nicely on a T-table and graph.

As mentioned earlier, we don't recommend this approach to finding an adequate shoe pattern; we just happened to luck out on this occasion. It's best to already have an example of a growth pattern before you start the lesson (find one of your own shoes or borrow someone's). You don't want the lesson to be dependent on luck, and it also helps to have the pattern in advance so you'll be prepared for the algebra that's generated.

We named the big circle in the middle Size 0 and then counted the curved lines above and below for each increasing size. Students saw patterns on the T-table and shared quite a few relationships they saw:

Take the size and add it to itself to get the number of curved lines.
Take the size and multiply by two to get the number of curved lines.
The sizes go up by ones.
The curved lines go up by twos.

Then we modeled graphing the data from the T-table. From the T-table and graph we challenged students to generate a formula that described the shoe pattern growth. We used letter variables to represent the size, number of lines, and curves. Students talked to a partner about how to describe the growth and how to condense that description into an algebraic equation. They had little trouble accomplishing this task, coming up with such equations as $S + S = C$, $2S = C$, $S = C / 2$.

The use of the shoe provided a relevant, visual model for students to use in both describing patterns and representing at least one of the patterns algebraically. The lesson proved a success and left rich possibilities for exploring other shoe growth patterns and describing them algebraically.