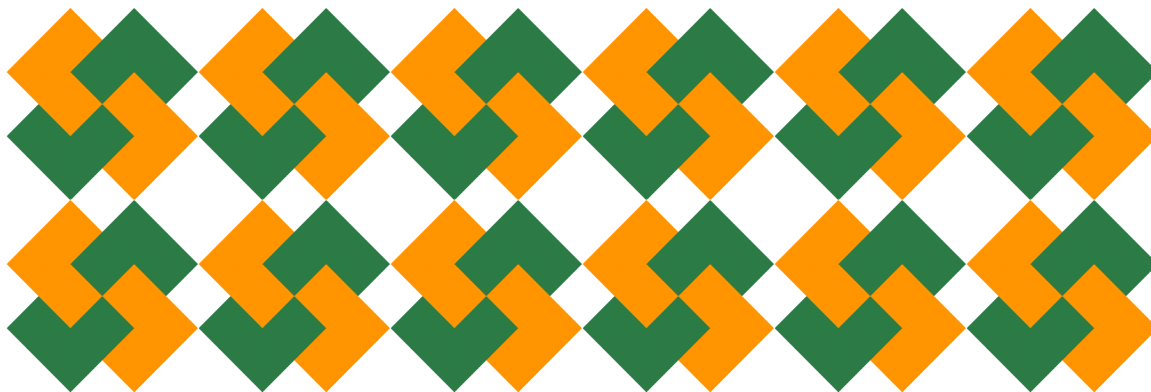# Exploring Geometry and Measurement Concepts through Quilt Design

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Participants will be guided through the use of Digi-Quilt (a computer manipulative-based design environment) for student exploration of geometric and measurement concepts. In addition, participants will experience hands-on inquiry-based approaches to learning the same mathematical concepts with concrete materials.

Topics addressed in the activities include polygons, symmetry, transformations, similarity, tessellation, perimeter, area, fractions, and patterns. Through active inquiry of these topics, students use mathematics in sense-making contexts and express themselves creatively, resulting in deeper mathematical understanding.

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Agenda

1. Introduction
2. Access to Digi-Quilt

   Free downloads: http://home.cc.gatech.edu/Kristin/39 (Kristin Lamberty)

   http://www.squeak.org/

3. The Digi-Quilt Environment
   a. Basic grids
   b. Shapes and properties

      Basic; all; creating shapes
   c. Colors

      Numerical representations of fractions
   d. Rotations [symmetry], translations, and location
   e. "Over-grids"
   f. Save or Open files
   g. Swap feature
4. Printing files
   a. Importing files to Word
   b. Tiling with img files
5. A few [more] ideas for teaching and learning with Digi-Quilt
6. Concrete Manipulatives
   a. Simple nine-patch

      Duplicate designs

      Create designs
   b. Understanding fractions as portions of the whole

      Equivalent fractions; flexible naming
   c. Recording sheets for designs
   d. Analyzing fractional portions
   e. Analyzing area and perimeter
   f. Comparing student representations
   g. Analysis and duplication of designs
7. Literature Connections—Story Quilts

Ideas for Teaching and Learning with DigiQuilt

All Levels, Starting with Primary Grades

1. **Play**. Let students simply explore without constraints.
2. Use the smallest grid (2x2) for student inquiry about **simple fractions**: ¼, ½, and ¾. Use only the squares from basic shapes. The color buttons will display the fractional value (of the whole square; area model) of the particular color.
   a. What fraction shows up on the color button when you put one square into the grid?
   b. How many ways can you fill the grid?
   c. Fill the grid with just one color. What fraction is showing on the color button?
   d. How many different fraction addition sentences can be made with different colors, e.g., ¼ (blue) + ½ (green) + ¼ (yellow) = 1 (whole grid).
3. Experiment with filling different grids (3x3, and 4x4) with one square of color at a time.
   a. What patterns do you see in the fractions that show up on the grid?
   b. What happens that you might not expect?
4. Have students explore the relationships between **area** (square units) and **perimeter** (linear units). Using the 4x4 grid, create images using only the square from the basic shapes. (One small square on the grid is one square unit.)
   a. What is the area of the image? What is the perimeter of the image?
   b. If you create a design with more than one color, what is the area of each of the colors? What are the perimeters?
5. When students are comfortable with the simple fractions, add the triangle to the inquiry. The questions from #2 and #3 above also apply. Note: You would not use the triangles for perimeter at the primary level, but you could use them for investigating area.
   a. How many triangles can fit in the grid and cover the whole surface with only one layer? (This requires introduction of the turning tool for rotating shapes.)
   b. If you use two triangles, how much (what fractional part) of the grid is covered? Try different combinations of triangles and colors. What do you notice about the fractional parts? Can you describe any patterns?
   c. Try different combinations of squares and triangles. What do you notice?
6. Explore how different **shapes combine to make a new shape** using the 2x2 grid, 3x3 grid, and 4x4 grid.
   a. How can you make different sized squares; rectangles; triangles; pentagons; *n*-gons?
   b. Write a sentence or paragraph of directions for making your shape.
7. Read *Grandfather Tang's Story* with your students. Note: DigiQuilt does not allow the same flexibility as the loose Tangrams would, but students should be able to notice the similarities and get some ideas for how they might use the shapes.
   a. Create a picture using the 4x4 grid. (This requires introduction of the turning tool.)
   b. Write a sentence or paragraph of directions for making your shape.
8. Explore **line symmetry** with the 2x2 grid, 3x3 grid, and 4x4 grid.
   a. What do you notice about symmetry while using the various grids?

Continuing with Intermediate Grades

9. Explore **rotation** and **radial symmetry**. (Requires rotation tools.)
   a. Create an image using the turning tools.
   b. Create an image with radial symmetry.
   c. Find a way to create an image with radial symmetry without using the turning tools.
   d. Describe the image using mathematical terms.
10. Create pictures to **illustrate a story**. This activity can be done with informal mathematical vocabulary at first. Introduce correct terminology once students have had experiences to connect with the terminology.
    a. Create a series of illustrations as a storyboard.
    b. Write a story and make a picture book with your words and illustrations.
11. Provide a design for students to **analyze and duplicate**.
    a. Write down the steps you can take to duplicate the picture.
    b. Find more than one way to duplicate the design.
12. Explore **fractional units with perimeters and area**. Use only the **large square, small square**, and **rectangle** (from "all" shapes) to create polygons. A unit is defined as the whole grid with the fraction feature that is built into the program.
    a. How are the large square and the rectangle related?
    b. How are the large square and the small square related?
    c. How are the small square and rectangle related?
    d. For any square or rectangle that you construct, how are the perimeter and area related?
13. Support students' use of **mathematical vocabulary** by provide an image that students must describe in terms of shapes, patterns, rotations, and/or fractional parts.
14. Write fraction sentences to describe a color arrangement and explore **equivalent fractions**.
15. Create a PowerPoint presentation that shows the evolving creation of a design (possibly with written directions).
16. Explore **tessellations**. Create a design in DigiQuilt that tessellates to reveal another image (when copied and pasted repeatedly to a word document).

Continuing with Middle Grades

17. Find the **areas and perimeters** of shapes within a 4x4 grid. One square of the grid is equal to one square unit. (This will require that students have had an introduction to the Pythagorean Theorem, as the hypotenuse of the large triangle and the legs of the small triangle will have some relation to the square root of 2.)

Extensions for High School Students

18. Extend work to creating designs on graph paper. Explore concepts of self-similarity leading to understanding of fractals.
19. See **many** more ideas in the *Mathematical Quilts* books by Venters and Ellison.

Literature 'Entry Points'

Brumbeau, Jeff and Gail de Marcken (illustrator). *The Quiltmaker's Gift*. New York: Scholastic, 2000. Ages 4-8.

Brumbeau, Jeff and Gail de Marcken (illustrator). *The Quiltmaker's Journey*. Orchard, 2005. Ages 4-8.

Flournoy, Valerie & Jerry Pinkney (illustrator). *The Patchwork Quilt*. Dial, 1985. Ages 4-8.

Hopkinson, Deborah & James Ransome (illustrator). *Sweet Clara and the Freedom Quilt*. Dragonfly Books, 1995. Ages 4-8.

Line, Joanne Larsen & Nancy Loving Tubesing (illustrator). *Quilts from the Quiltmaker's Gift*. Scholastic, 2001.

McKissack, Patricia C. and Cozbi A. Cabrera (illustrator). *Stitchin' and Pullin': A Gee's Bend Quilt*. New York: Random House, 2008.

Polacco, Patricia. *The Keeping Quilt*. Aladdin, 2001. Ages 4-8.

Tompert, Ann & Robert Andrew Parker (illustrator). *Grandfather Tang's Story: A Tale Told with Tangrams*. Dragonfly Books, 1997. Grades K-4.

Paul, Ann Whitford & Jeanette Winter (illustrator). *Eight Hands Round: A Patchwork Alphabet*. Harper Collins, 1991. Ages 8 and up.

Woodson, Jacqueline & Hudson Talbot (illustrator). *Show Way*. Putnam, 2005. Grades 3-5.

Mathematical Quilts Activity Books with Blackline Masters

Ellison, Elaine and Diana Venters. *Mathematical Quilts: No Sewing Required*. Key Curriculum Press, 1999, Grades 6-12.

Venters, Diana and Elaine Krajenke Ellison. *More Mathematical Quilts: No Sewing Required!* Key Curriculum Press, 2003, Grades 6-12.
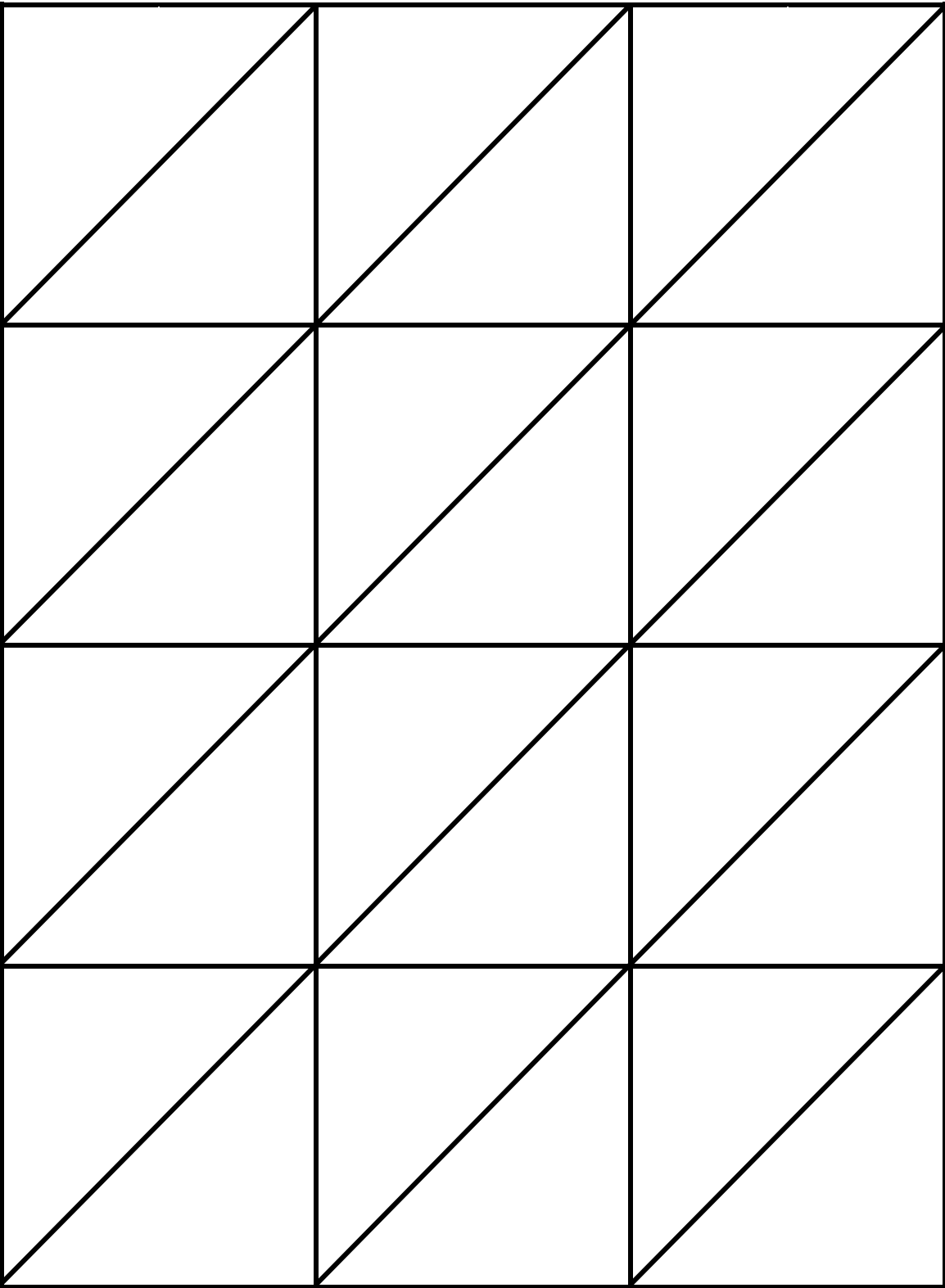
Templates for making card stock quilt pieces
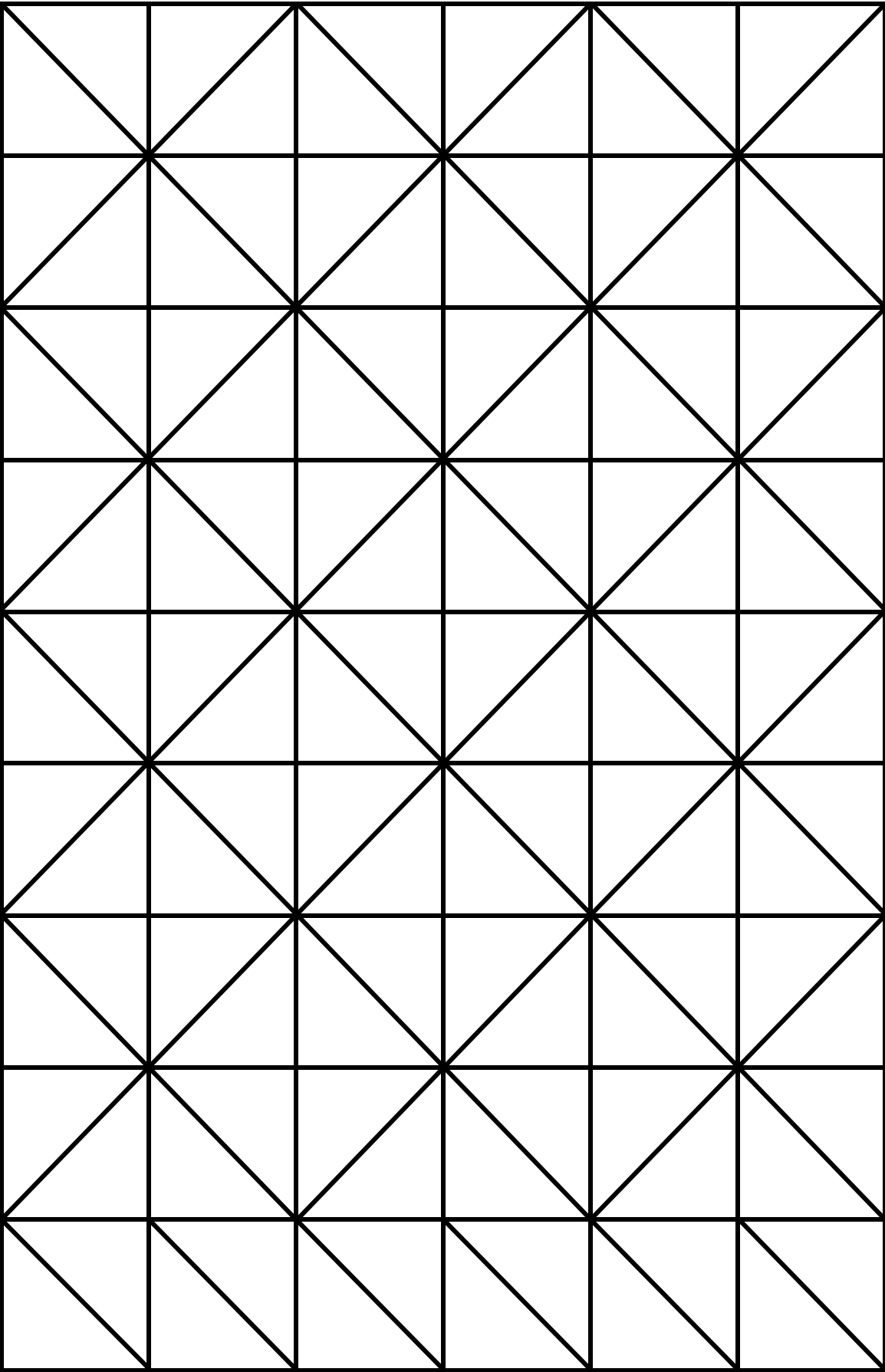
Nine-Patch Work Space
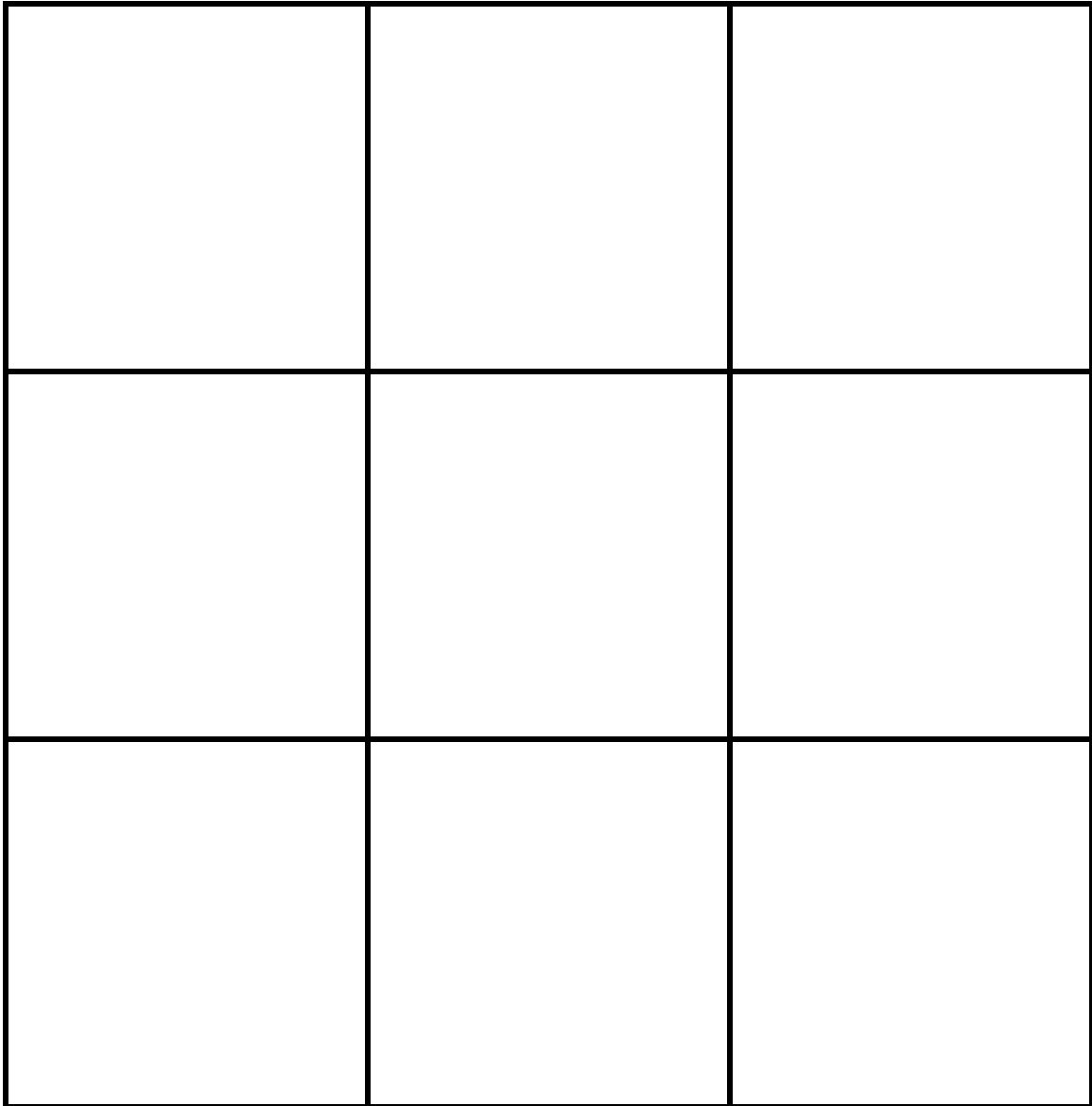
Small Squares

Large Triangles

Small Triangles

Rectangles

Recording Sheet