Is This Geometry Class or Art Class? An Integrated Approach

By Dr. Beth M. Vinson

Introduction

With some understanding of the link between geometry and art, teachers can effectively integrate the two subjects into their lesson plans. Geometry is the study of shapes, and those shapes are created with line segments. Shapes and line segments make up the various forms of art that are all around us. This paper provides three examples of K-6 integrated geometry and art lessons: a 36-dot design exercise, a tessellation activity, and an activity for drawing a curve using line segments. The 36-dot design has been completed by many elementary-school children who draw their own dots and create their own unique designs. The tessellations activity provides students with endless possibilities for tiled designs and also teaches fractions. The activity for drawing a curve using straight line segments provides opportunities for problem solving and critical thinking. A bibliography of related children's literature follows the lesson plan discussions.

36-Dot Design

The first activity is the 36-dot design. This is an original geometry and art activity that teaches the concepts of row, column, line, line segment, and rotational symmetry. The concepts of row and column are necessary to interpret graphs and charts and to read tables in a computer database or spreadsheet. Students will use Figure 1 and pencils to complete the rotational symmetry design.

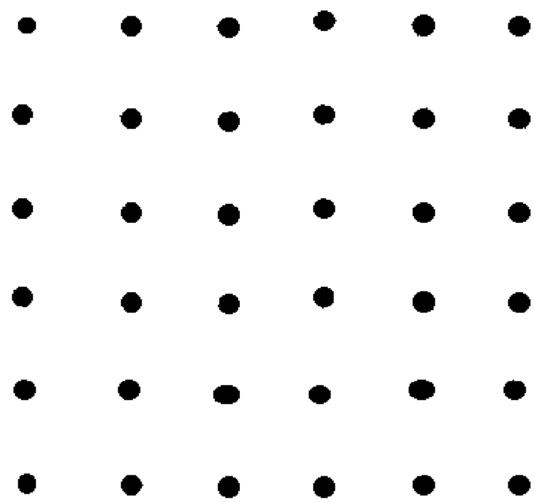


Figure 1 36-Dot Design Grid

The first two concepts are related: row and column. Use Figure 2 as a visual while explaining the two concepts to students. Tell students that a row is like a **row** of corn. Brush your hand back and forth across the air and tell students to imagine that they are feeling the tops of the corn plants. A row goes back and forth or left and right. Have students trace their fingers across the first row of dots. Then have them locate the bottom row of dots. The column is like the tall pillars that hold up the front part of many prominent buildings. Columns stand up in order to hold up the buildings. With a long motion of your arm, trace in the air in an up-and-down motion and say "column." Have students locate the six different columns of dots on their 36-dot design grid.

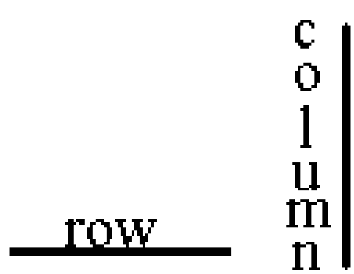


Figure 2 Row and Column

The next two concepts are also related: line and line segment. A line goes on forever in both directions. A line segment is a piece of a line. Ask students to decide whether they will be using "lines" or "line segments" in their designs today. The concept of rotational symmetry is discussed at the end of the activity because when students turn their 36-dot designs upside down, sideways, or right side up, the design looks the same. In other words, as the design is rotated, it appears the same from several angles.

The next step is to draw the design step-by-step with the students using the row and column terminology. For example, say: "Go to the first row on your grid. Put your pencil on the third dot. Draw an upside-down v connecting the third and fourth dots." Rotate the paper a quarter turn and do the same step three more times. It is imperative to have a transparency or a large scale board drawing and model each step. It is best to draw no more than two line segments before rotating a quarter turn. Your finished design will look like Figure 3.

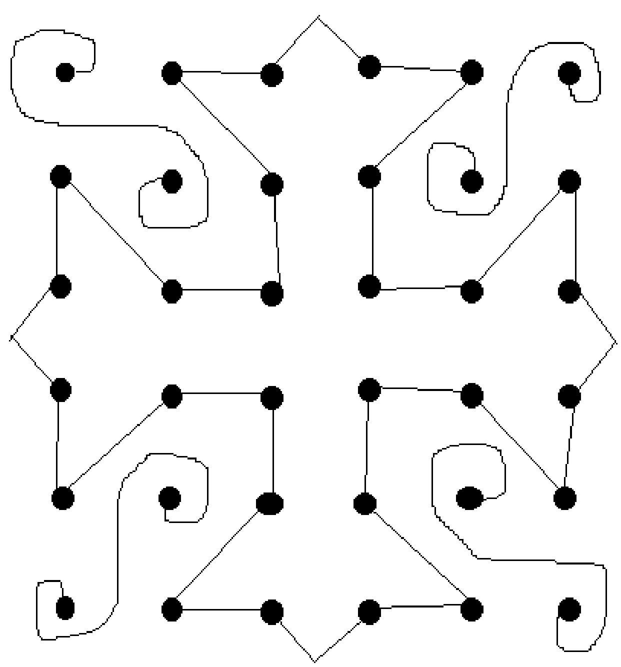


Figure 3 36-Dot Design Finished

Students may add color to their design. In addition, some of the older students may want to personalize their designs like the examples shown in Figures 4 and 5.

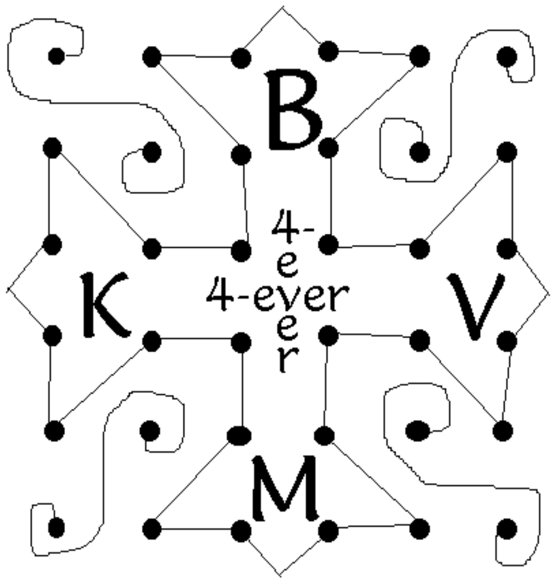


Figure 4 36-Dot Design Finished - Boyfriend & Girlfriend Initials

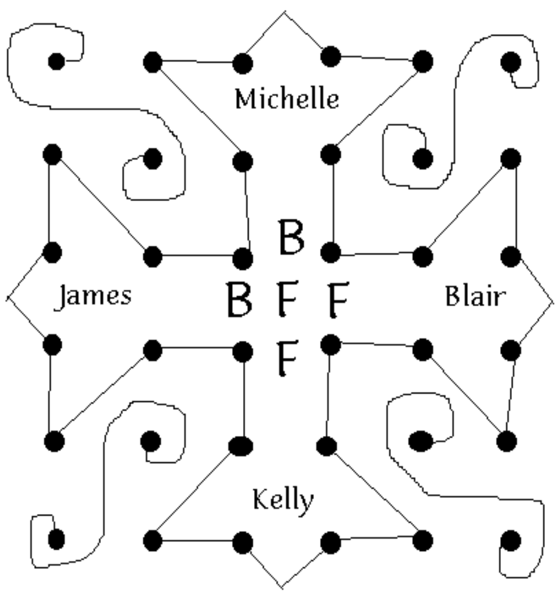


Figure 5 36-Dot Design Finished - BFF (Best Friends Forever)

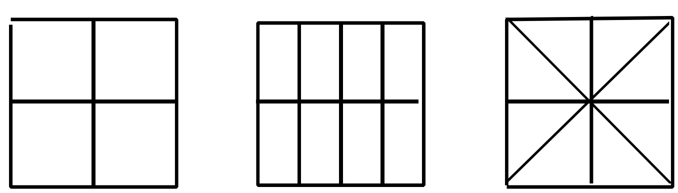
Notice that this activity is called a 36-dot design: "6 rows of 6 dots in each row" or "6 columns with 6 dots in each column" (6 x 6 = 36). The 36 dots make the shape of a square. So we can say:

"Six squared is equal to thirty-six," or "Six to the second power (length times width) equals thirty-six." Then we can follow up by asking a series of leading questions and prompting the students to answer. For example: "What other total numbers of dots could we use to make a square? Well, 5 x 5 would total 25 dots; a 4 x 4 would total 16 dots; etc. Could we have a 21-dot design in the shape of a square? No. How do we know? Because there is not a number times itself that equals 21. That is why it is called 'squaring a number."'

Tessellations

The second geometric art activity involves tessellations. A tessellation is a design made with two-dimensional geometric shapes. Examples of tessellations include bathroom tile floors, ceiling tiles, and mosaics. There are two important aspects of a tessellation: (1) the geometric shapes are pushed together so that there are no gaps between the pieces; and (2) the geometric shapes do not overlap each other. Think of paving stones on a walkway. What would happen if there were gaps? It would create a hole or a crack to fall into. What would happen if one stone overlapped another? If you dragged your feet in the least bit, you might stumble. An abbreviated way to describe the characteristics of a tessellation is to say that they have no gaps and no overlaps. So, can a tesselation be formed using circles? No, because you would leave gaps.

To begin the exercise, draw three square blocks: a block with four squares in it, a block with eight rectangles in it, and a block with eight triangles in it (see Figure 6).



The following is an example of how the coloring of each of these three large blocks can be used to teach (or review) fractions. The next few sentences are written using the language that we would use with elementary school students. It is important to note that each step is modeled by the teacher.

"Let's start with the block divided into four squares. Take your blue crayon and color in one of the square sections. How many squares are there in all? One, two, three, four. [Write a 4 on the board.] How many squares are colored in? One. [Write a 1 above the 4 as a fraction.] Have students say 'one-fourth of my squares is colored in blue.' Now color another square blue that is right beside the first one you colored. How many squares do we have in all? One, two, three, four. [Write a 4 on the board to the right of 1/4.] How many squares are colored blue? One, two. [Write a 2 above the 4 as a fraction.]" Follow these same steps to do 3/4 and 4/4. Figure 7 shows the steps for completing the fourths fractions.

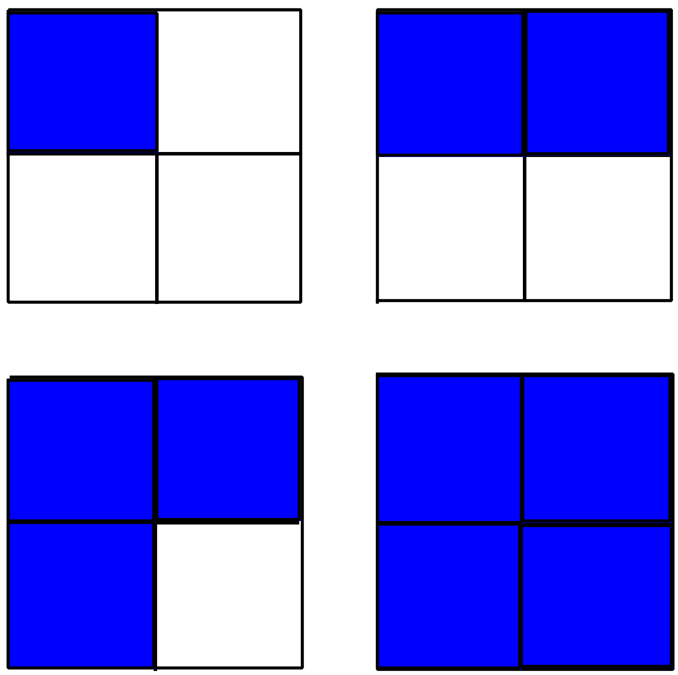


Figure 7 Fourths, Using Square Regions

After students have completed their fourths, they are ready for the eighths. Take a red crayon and step-by-step color in each one of the rectangles, making sure to color it, look at it, say it, and show it in fractional form on the board. After the students do the rectangles, they will proceed to the triangles, using a yellow color. The final question that you will ask them to discuss in their groups is this: "If there are 8 triangles and 8 rectangles, what can be said about the surface area of each triangle and each rectangle?" Explain that since the blocks are the same size and the triangles and rectangles are equal pieces of the whole block, then each triangle has the same surface area as each rectangle. After you have colored each of your squares blue, each of your rectangles red, and each of your triangles yellow, then you may cut each one out. Cut them so that you have 4 blue squares, 8 red rectangles, and 8 yellow triangle pieces. Next, position them on a piece of paper so that you form a tessellation - not necessarily a pattern, and not necessarily straight edges on each side. Just follow the two rules: no gaps and no overlaps. After you are satisfied with the look of your tessellation, pick up one piece at a time and glue it down. Sometimes tessellations are called quilt patterns. Can you see why?

Figure 8 shows an example of a completed tessellation. The design possibilities are endless.

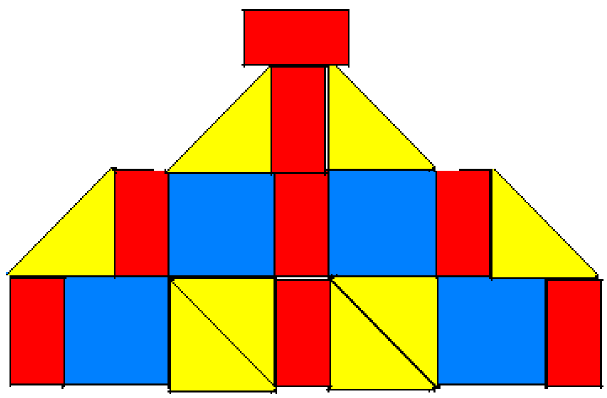


Figure 8 Example of a Completed Tessellation

Drawing a Curve Using Straight Line Segments

These are the concepts that will be taught or reviewed in this lesson: line, line segment, curve, pair, couple, numerical order, inverse numerical order, intersection, angle, and vertex.

Ask students the key question: “Can you draw a curve using straight line segments?” [Most students will say “no” because rulers are used to draw straight line segments.] Using rulers, pencils, and Figure 9, notice that the left-hand side of the vertex has numerals going in numerical order. The other side has them in an inverse numerical order from top to bottom. “Inverse” sounds like “reverse” and means the same thing. An example of inverse numerical order would be the countdown to a space shuttle launch: ten, nine, eight, seven,...

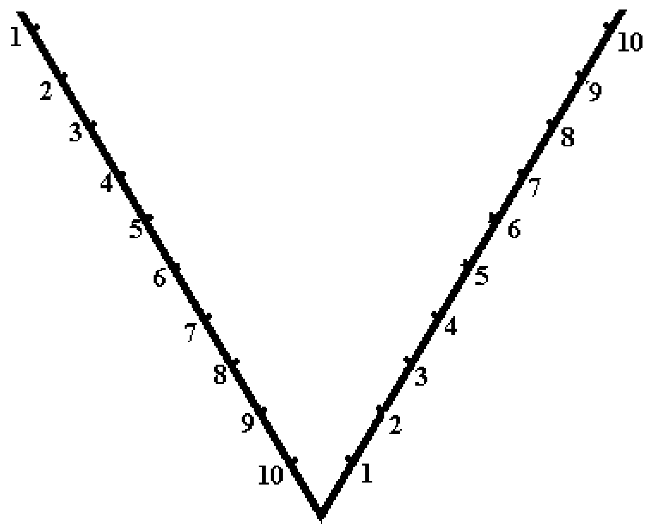


Figure 9 Numbered Angle

The vertex is the point at which the two line segments of the angle meet each other. Point these things out to students. In the previous two activities we noticed the difference between a line and a line segment. Throughout this activity ask students to correct you if you say "line" because we are actually drawing line segments. [Say "line" instead of "line segment" enough times that they can have fun catching you. This will teach them to pay attention to the difference.]

Tell students to find the numeral 5 on each side of the angle. Model for them how to hold the ruler and draw a line segment connecting the two fives. Mention that the two fives form a "pair" or a "couple" of numbers. Relate this to a "pair" of shoes and a married "couple." Make sure that the students know to have at least two pressure points applied to their ruler so that the ruler will not move when they draw the line. [Did you catch that? I should have said "line SEGMENT."] Also, model for them how to push the pencil along the straight edge of the ruler as they draw the line segment. (Believe it or not, drawing line segments with rulers is a skill that many teachers find difficult to teach.) Now have students draw a line segment between the pair of sixes. Their papers should look like Figure 10 at this point. Mention that one line segment just crossed the other line segment. Then point to where the two lines cross and tell them that this is called the **intersection.** Talk about a roadway intersection with a stop sign or traffic light positioned at the point where the two roads cross.

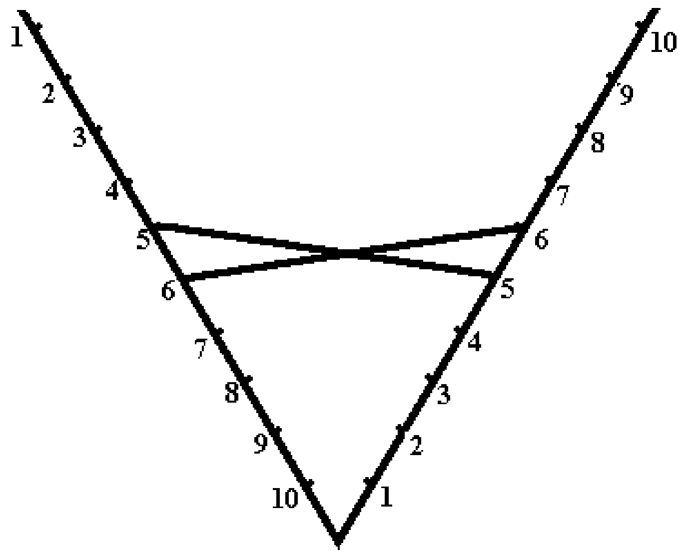


Figure 10 Intersection

Continue to connect each pair of numerals with line segments until all ten pairs are connected with line segments. What you end up with is something that resembles a waffle cone for ice cream. The top rim of the cone is in the shape of a curve. Figure 11 shows a completed drawing.

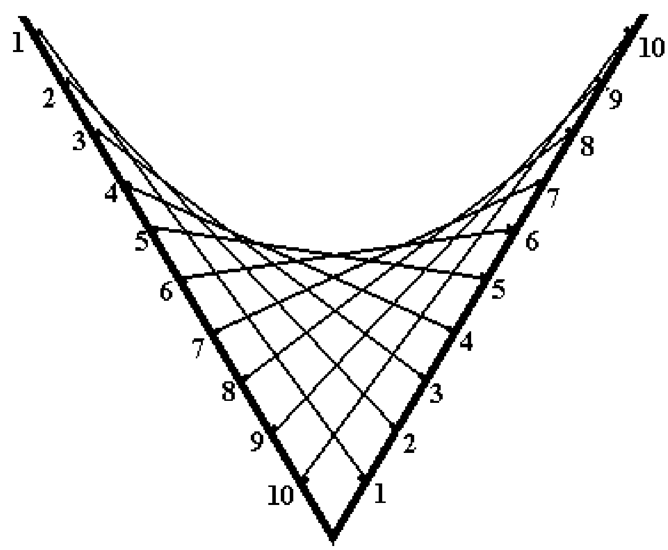


Figure 11 Drawing a Curve - Finished Design

You may color each line segment a different color, or color each shape within the cone, as shown in Figure 12. Be creative. Have fun. Can you teach geometry and art together? Yes, we just did.

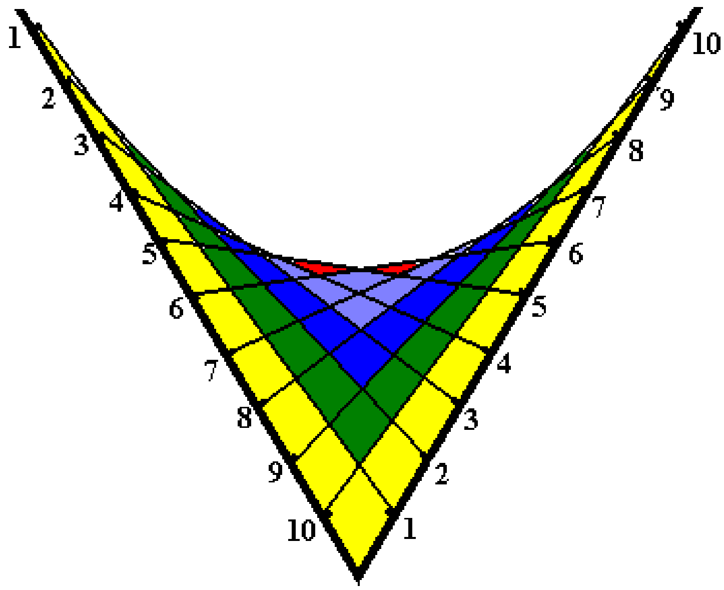


Figure 12 Drawing a Curve - Finished Design, Different Colored Chapes

Annotated Bibliography

Related Children's Literature

Burns, M. (1997). *Spaghetti and Meatballs for All!* New York: Scholastic. (ISBN: 0-590-94459-2)

> The seating for a family reunion gets complicated as people rearrange the tables and chairs to seat additional guests. The concepts of perimeter and area are introduced.

Burns, M. (1994). *The Greedy Triangle.* New York: Scholastic. (ISBN: 0-590-48991-7)

> Dissatisfied with its shape, a triangle keeps asking the local shapeshifter to add more lines and angles until the triangle doesn't know which side is up.

Cole, J.W., & Welch, K. (1988). *Shapes of Things to Come.* New York: McGraw-Hill. (ISBN: 0-07-064004-1)

> This colorful book points out different shapes in the environment. For example, a triangle is a yield sign.

Connelly, N.O., & Thornburgh, R.M. (1998). *The Cuddly Beasties Shapes Book.* China: Paradise Press. (ISBN: 7-86943-00618-6)

> This is a pop-up book about "beasts" who make shapes.

Flourney, V. (1985). *The Patchwork Quilt.* New York: Dial Books. (ISBN: 0-8037-0097-0)

> A grandmother and granddaughter work together on a quilt of geometric fabric scraps.

Friedman, A. (1994). *A Cloak for the Dreamer.* New York: Scholastic.
(ISBN: 0-590-48987-9)

> When a tailor asks each of his three sons to make a cloak for the archduke, they each use geometric patterns, but the third son's design reveals his desire to travel the world rather than follow in his father's footsteps.

Guile, G. (1986). *I Love to Learn About Sizes, Shapes, and Opposites.* New York: Waldman Publishing Corporation. (ISBN: 0-70097-00221-8)

> This book illustrates the concepts of big, bigger, biggest, square, big vs. little, rectangle, tall, taller, tallest, tall vs. short, triangle, corners, large, larger, largest, large vs. small, circle, high, higher, highest, high vs. low, fat, fatter, fattest, and fat vs. thin.

Hulme, J. (1991). *Sea Squares.* New York: Hyperion Paperbacks for Children. (ISBN: 1-56282-520-8)

> Children will take a step from basic counting into multiplication with these delightful sea creatures as guides. Numbers 1 - 10 are squared in illustrations of sea creatures. The end of the book provides written information about each of the sea creatures in the story.

McMillan, B. (1991). *Eating Fractions.* New York: Scholastic Publishing. (ISBN: 0-590-43770-4)

> Food is cut into halves, thirds, and fourths to illustrate how parts make a whole.

Neuschwander, C. (1997). *Sir Cumference and the First Round Table.* Watertown, MA: Charlesbridge Publishing. (ISBN: 1-57091-152-5)

> Assisted by his knight, Sir Cumference, and using ideas offered by the knight's wife, Lady Di of Ameter, and son, Radius, King Arthur finds the perfect shape for his table.

Pallotta, J. (1999). *The Hershey's Milk Chocolate Fractions Book.* New York: Scholastic. (ISBN: 0-439-13519-2)

> This book uses the Hershey's candy bar to teach fractional parts of a whole. Fractional parts of a set are introduced as ingredients in the candy bar.

Paul, A.W. (1991). *Eight Hands Round. A Patchwork Alphabet.* New York: HarperCollins. (ISBN: 0-06-024689-8)

> The names of Early-American patchwork patterns are used for the letters in this alphabet book. A sea of geometric shapes are tessellated to make the various patterns.

VanCleave, J. (1994). *Geometry for Every Kid.* New York: John Wiley & Sons. (ISBN: 0-471-54265-2)

> This bestseller book contains activities, ideas, projects, and things to do to make learning geometry fun. Illustrations provide descriptions for possible worksheets, gameboards, etc.

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