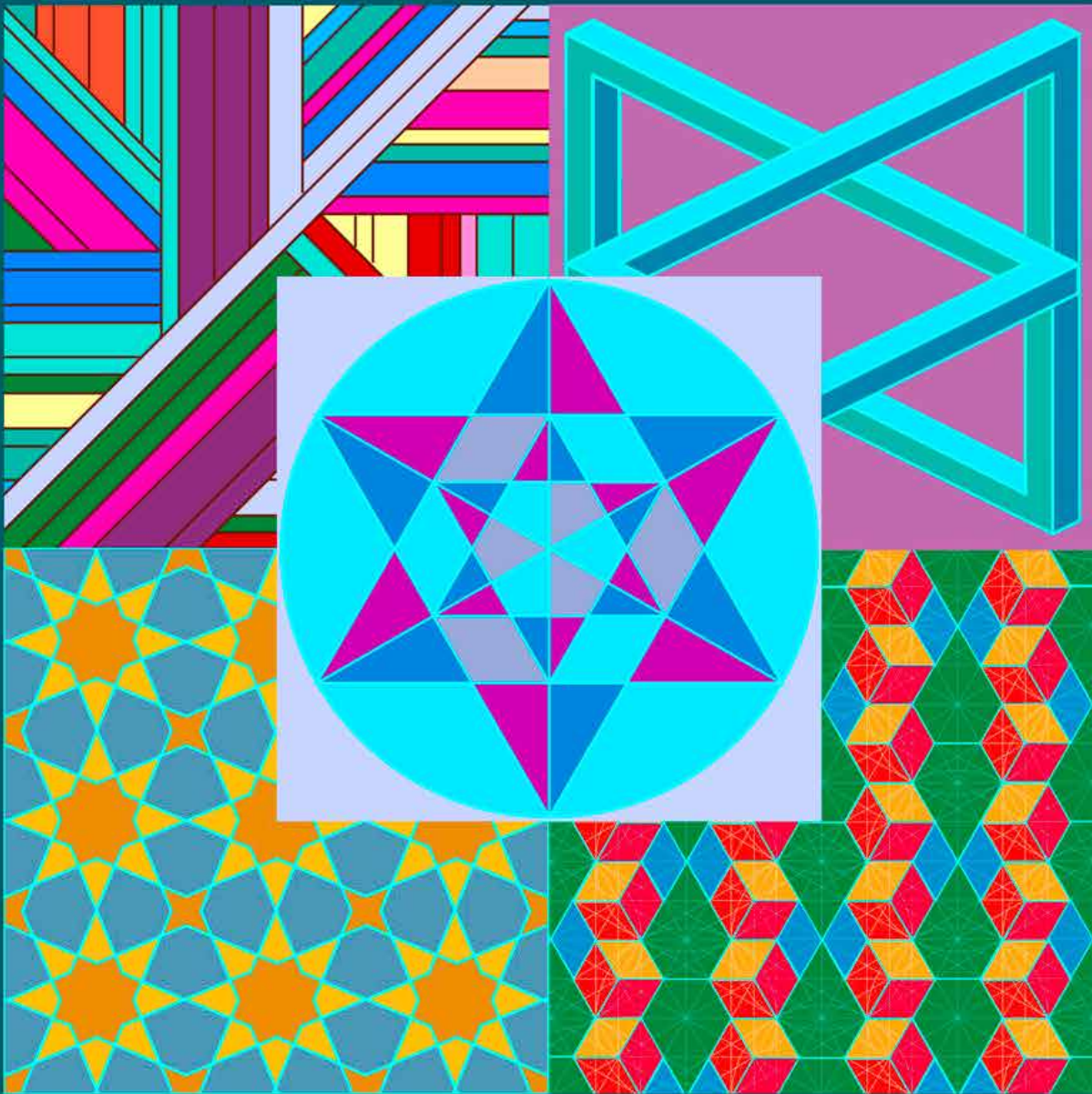


# BIG BUNDLE OF GEOMETRIC COLORING DESIGNS



# DENISE GASKINS

AUTHOR OF *LET'S PLAY MATH: HOW FAMILIES CAN LEARN MATH TOGETHER AND ENJOY IT*

# Ready-to-Color Designs

## Doodling With Shapes

DOODLING GIVES OUR MINDS A chance to relax, wander, and come back to our work refreshed. And though it goes against intuition, doodling can help us [remember more of what we learn](#).

Math doodles let us experiment with geometric shapes and symmetries. We can feel our way into math ideas gradually, through informal play. Through doodles, our students will explore a wide range of mathematical structures and relationships.



*Our own school experiences can make it hard for us to teach. What we never learned in school was the concept of playing around with math, allowing ideas to “percolate,” so to speak, before mastery occurs, and that process may take time.*

—JULIE BRENNAN



I created these coloring pages for my homeschool co-op math students. We used them to play the Notice and Wonder game (see Annie Fetter’s YouTube video “Ever Wonder What They’d Notice?” at [youtu.be/a-Fth6sOaRA](https://youtu.be/a-Fth6sOaRA)) and to talk about symmetry. We used them for time-fillers when children finished a project early or for take-home sheets when we were running late.

The lines of each design are colored nonphoto blue, in case you want to scan your finished artwork. If you print them in grayscale (or on a black-only printer), they will come out a dim gray. I made them light on purpose, so it’s easy to ignore or color over the lines you don’t want to use in your picture.



**PREVIEW**



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# Dot Grids and Graph Paper

## Create Your Own Designs

CURIOUS ARTISTS FIND CREATIVE INSPIRATION in a simple page of graph paper. They discover lines and angles, shapes and symmetries—a whole world to explore, hidden within the grid.

For ideas on how to use the dot grids and graph paper pages, check out Kate Pickle's blog post [Graph Paper Drawing](#). Explore Dan Mackinnon's [Doodling with Froebel](#) and [Truchet Tiles](#) designs. Admire Cindy Hockman-Chupp's beautiful [Parallel & Perpendicular Art](#). Or play around with number-patterned doodles like Anna Weltman's [Spirolaterals](#).

See if you can make a rotational-symmetry design, like Don Steward's [Order 4](#) graphs—or for young children, fold a page in half and try to create a mirror image. For older students, try these [Grid Geometry Investigations](#).

Follow Michelle Houghton's directions for [How to Draw a Celtic Knot Pattern](#). Experiment with the more flexible rules in John Golden's [Knot Fun lesson](#). Or try my latest obsession: the [Ultimate Tutorial on Celtic Knotwork](#), which explores the link between knots and their underlying graphs.

Play a symmetry puzzle game. Draw a line of symmetry and fill in part of the design. Then trade with a partner to finish each other's doodles. Make more complex symmetry puzzles with additional reflection lines.



**PREVIEW**

**PREVIEW**



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# 3D Shapes and Impossible Figures

## Isometric Drafting

ARTISTS WHO WANT TO REPRESENT a three-dimensional object on flat (two-dimensional) paper have three basic options: oblique, isometric, or linear perspective drawing. This math art project explores isometric perspective, as seen in many computer games (do a search for “[isometric game art](#)”). You can read a quick discussion of the other styles on the [Nrich Maths 3D Drawing](#) page.

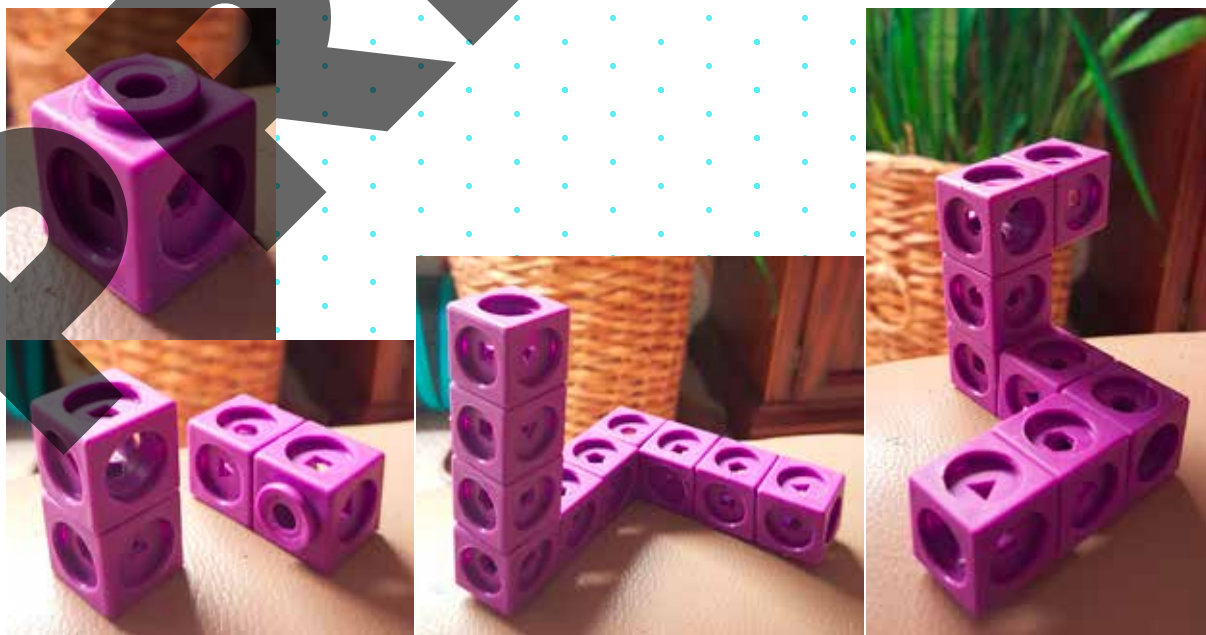
Before you try to draw anything, find a cubic block (or even a cardboard box). Pick it up and look at it from different angles. What do you see? Brainstorm a list of the things you notice.

Can you see the whole block at once? Do the edges appear perpendicular, or do they seem to meet at an angle? How does the light affect the colors of the block’s top and sides? Do all the sides of the block look the same, or do they change in different ways as you turn it?

Now take some time to get to know your isometric paper.

First, make sure it’s right-side up: Align the paper so you can connect four dots to make a horizontal rhombus that is wider than it is tall. I’ve provided pages with grids in vertical (portrait) and horizontal (landscape) format, so you can choose the page that best fits what you want to draw.

Notice the lines of evenly-spaced dots running at  $120^\circ$  angles to each other. Trace them with your finger. One set of dots slants from top right to bottom left. Another set slants from top left to bottom right. And the third set goes up and down. By following



this grid, you'll create pictures that appear three dimensional—even if they could never be built in the real world.

Some of the dot grid pages come in pairs. My students complained that the fine dots, which I prefer, were too faint to see. So I made a bolder-dots version of each page.



## How to Draw Minecraft Blocks

### (1) Make a Y.

Choose a dot to be the top front corner of your cube. From that dot, draw three lines that make a Y shape: one straight down, one up to the right, and one up to the left. Follow the grid to the next dot in each direction. That makes three edges of your cube.

### (2) Turn it into an M.

Make the two side edges of your cube by drawing lines from the two top points of your Y straight down to the next grid dot. These new lines will not come as far down the page as your first vertical line (the middle of your M).

### (3) Slant down for the bottom.

Connect the three vertical lines at their bases to make the bottom of your cube. Remember to follow the slanted lines of the isometric grid.

### (4) Slant up for the top.

Finish the top of your cube by turning the top of the Y into a rhombus. It should look like a diamond lying on its side.

The most common problem for beginners is that they try to make the base straight. Children know a block can sit on a table, so the bottom has to be flat, right? But once students get a feel for how the isometric grid works, they can really take off and have fun.

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# Symmetry and Islamic Design

## Beautiful Geometry

A CIRCLE IS PERHAPS THE simplest geometric shape, yet it can bloom into countless geometric patterns. Over the centuries, Islamic artists and architects crafted tremendous variety and beauty based on the symmetries created by dividing a circle.

You can build large, complex designs with the girih tile pattern blocks on pages 6–10. Print the blocks on cardstock and cut out the individual tiles (ignoring the tiny points). To turn a tile design into a picture cover it with a piece of paper and trace the *girih*—the strapwork lines that go through the midpoints of each block's sides.

Students may fill the shapes of an Islamic design with solid colors or make decorations inside them.

Since children often have trouble controlling a compass to make precise circles and arcs, this booklet contains several template pages with circles pre-divided into eight, ten, or twelve sections. You'll also find brief directions for five classic Islamic design patterns.

For even more fun, get a group of friends together to work on the same design. Cut out your finished projects and arrange them together like tiles. Look for the new shapes created along the sides or corners where the tiles meet.

Or get creative on your own. Use the pages that have multiple circles in a square or hexagonal grid to make an original geometric math art design. What patterns will you discover?

You can find more detailed step-by-step instructions for the Islamic design patterns at Eric Broug's [School of Islamic Geometric Design](http://School of Islamic Geometric Design) (SIGD.ORG). Learn more about using Islamic art in the classroom and see samples of student work on the SIGD.ORG [Classroom Resources page](#).



Tile pattern from a fountain at El Hedim Square in Meknes, Morocco (late 17th century).



Tile pattern from a tomb at Varamin, Iran (1262 CE). Each tile features a different, unique image, and the borders are filled with quotations from the Qur'an.



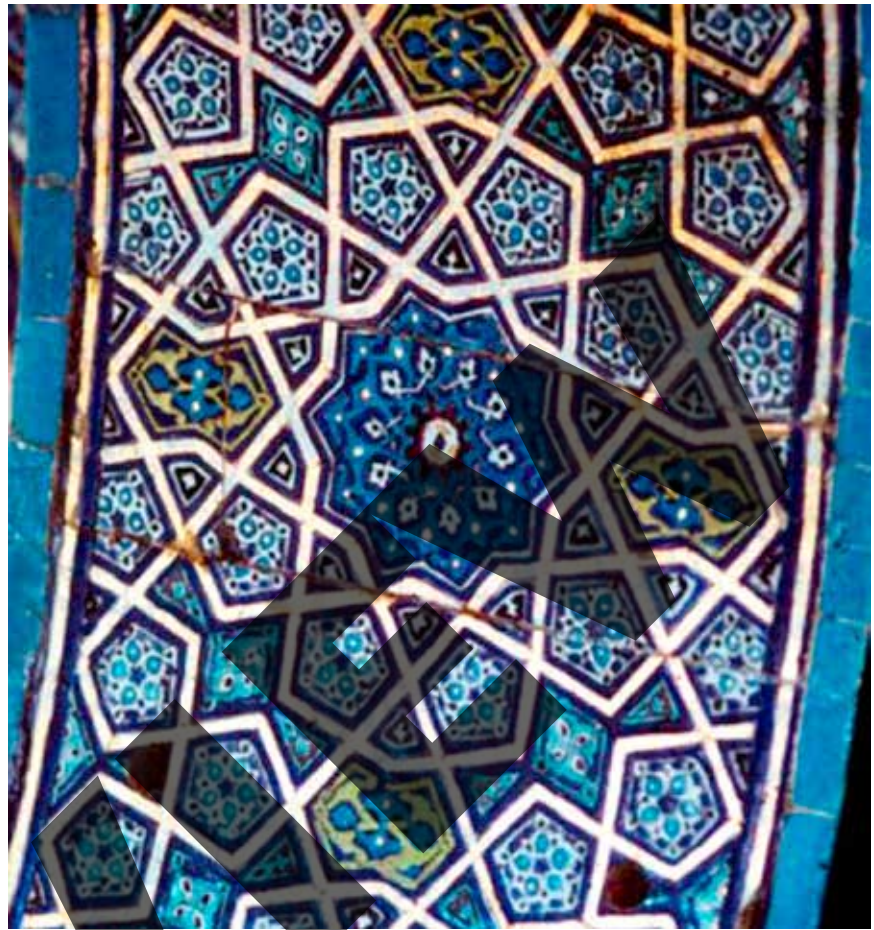
While using girih tiles to create a pattern, children may get frustrated by the way the tiles slide on a table. I find it easier to work on a rough surface, such as low-nap carpet.

When you find a pleasing arrangement, you may want to stick the paper tiles together with clear tape before tracing the girih. This prevents shifting while you draw. Afterward, you can cut the tape so the tiles are ready to use again.

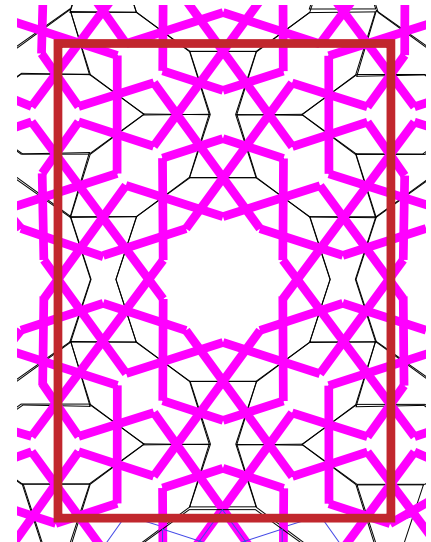
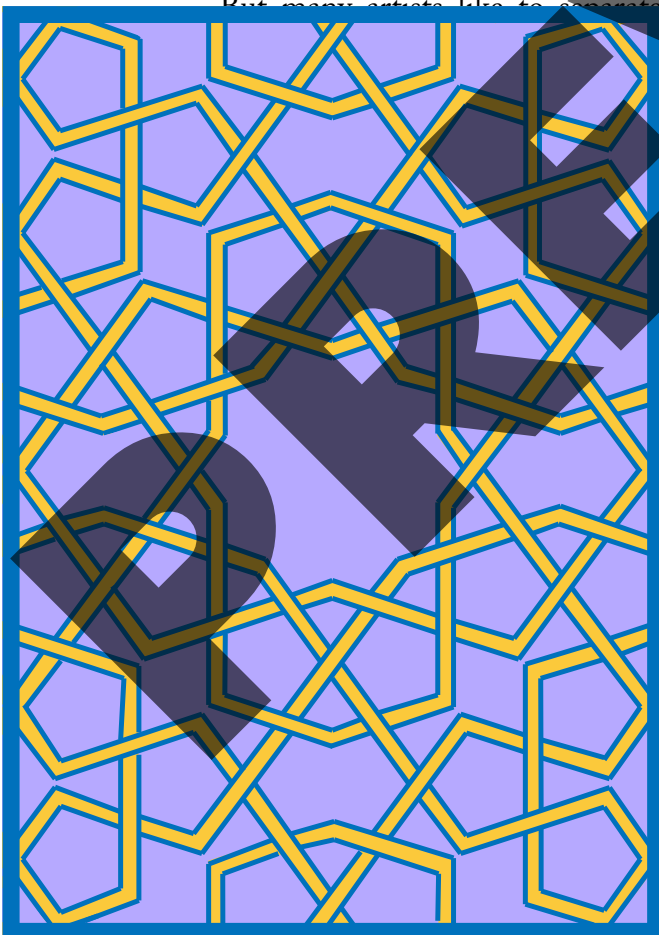
If your tiles don't align perfectly, adjust the girih lines on your tracing to make them straight. Decide where to put the frame around your drawing to make it fit with the corners of the girih shapes.

In this archway design from the Green Mosque, the girih form a single web of connected lines.

But many artists like to separate



Girih (strapwork) design on a decorated arch at the Sultan's Lodge in the Ottoman Green Mosque in Bursa, Turkey (1424 CE).



Pattern recreated with girih tiles, and then traced (in pink) with a border that touches the corners of the pentagons.

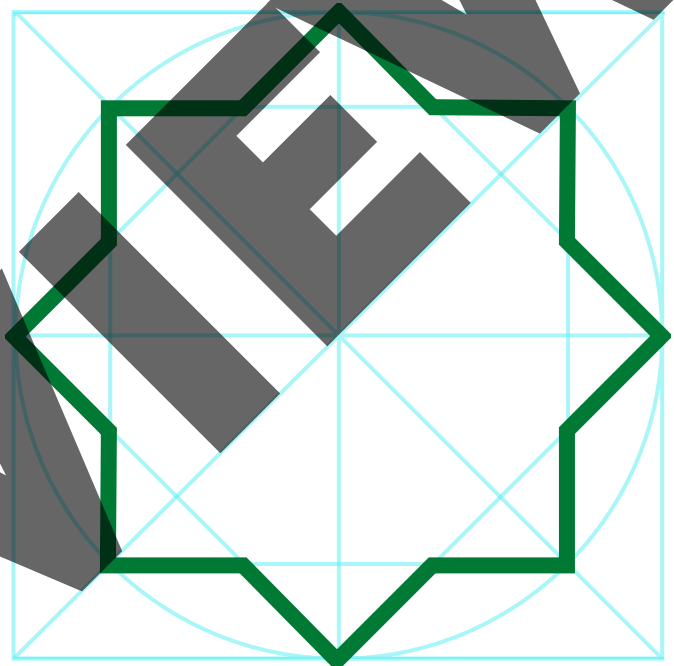
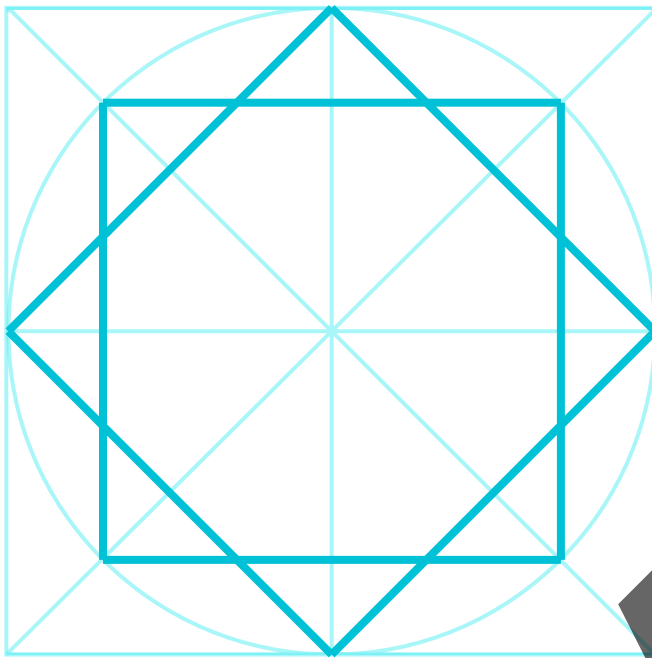
Finished design (left) with interwoven strapwork.

But many artists like to separate the girih into interwoven straps, with each line going over and then under at alternating intersections, as show in the design on the left. Students may choose either method, as they wish.

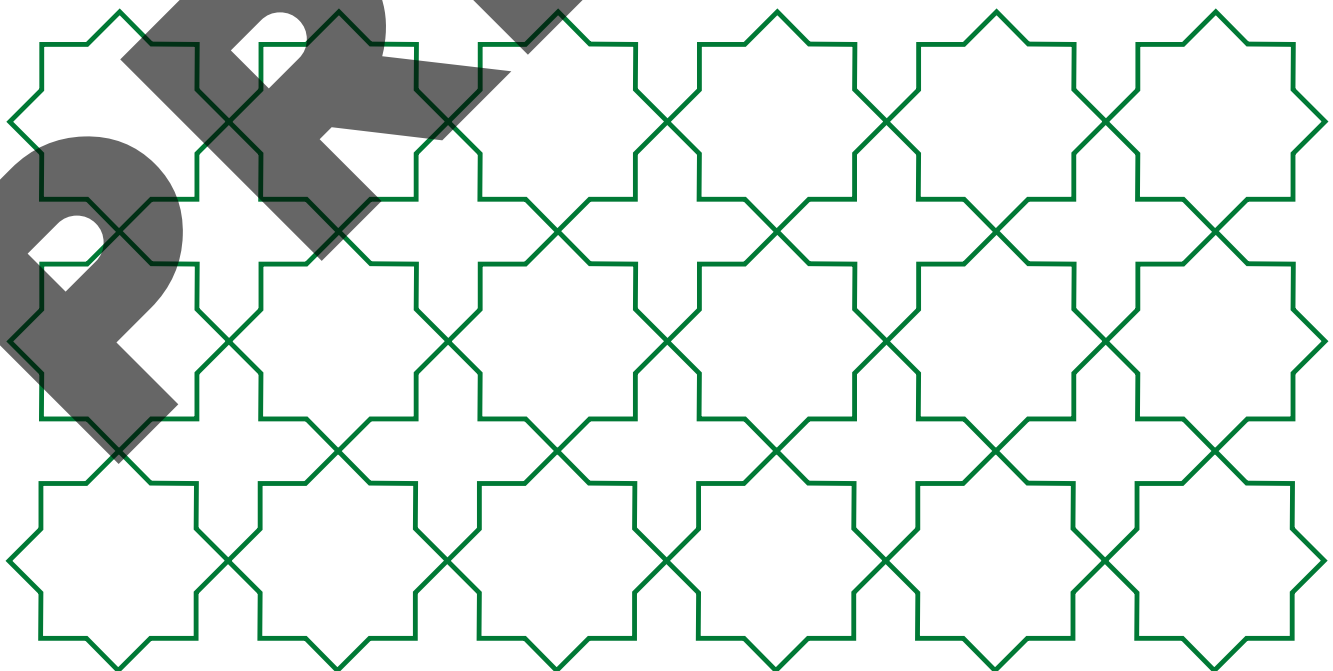


Our simplest pattern is an eight-sided star with an open center. Use the circle-in-a-square template on the next page. The first lines you draw will be construction lines, not part of your final design. Draw lightly with your pencil, so you can erase the extra bits later.

Pay attention to the places where the lines intersect the circle. Connect those points to make two squares, using a ruler to make precise, straight lines. This completes your construction lines.



Now take the marker or colored pencil you want for your final star. Darken the outer points of the squares, as shown here. Then erase your construction lines. Or if you wish to color in your star, you can shade right over the light pencil lines.





# Advanced Tessellation Patterns

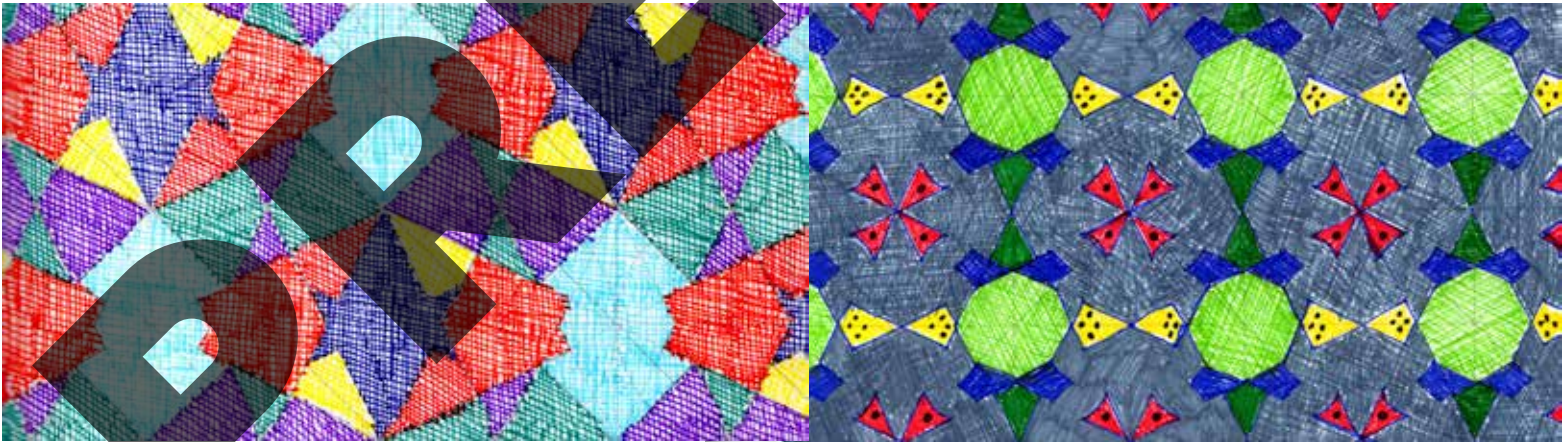
## Guidelines for Creative Play

ON THE TEMPLATE PAGES IN this math art activity guide, each construction guideline represents a choice for the creative artist. Each page will be different for every person. And whenever you come back to the same template, you'll discover a fresh design.

Some of the templates are based on classic Islamic tessellation patterns, others on geometric relationships that seem interesting.

- Print any template page and study the guidelines until you find a shape you like—perhaps a triangle, kite, or star. Trace it with your pencil. Then search out repetitions or rotations of your chosen shape.
- Look for a complementary shape between or overlapping the copies of your original discovery.
- Trace any additional lines you need to weave the shapes together into a design.
- Ignore the template lines that don't fit the design you are building. The light blue will disappear under the colors you apply.

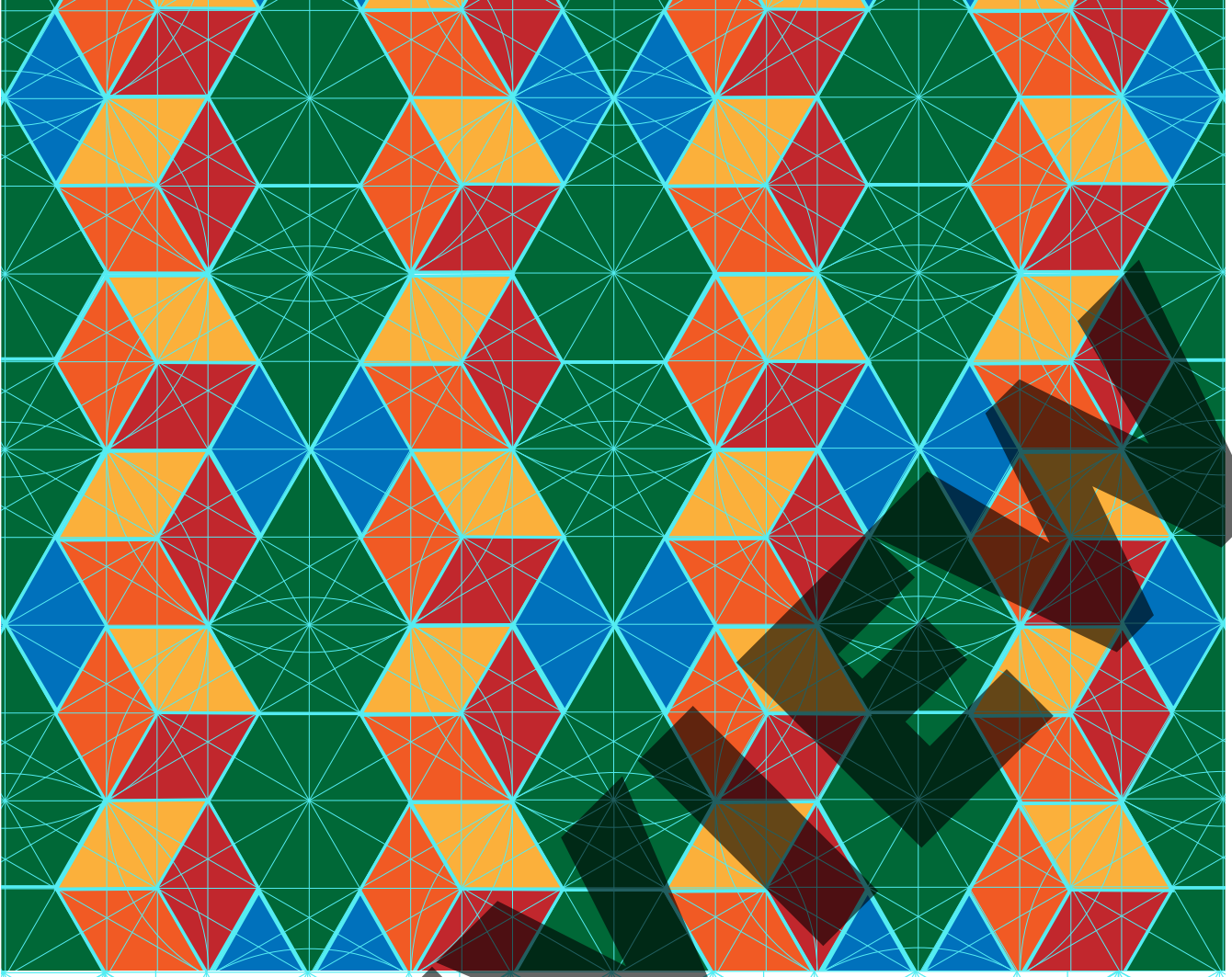
For example, below are two very different patterns my daughter and I created, both using the same template page. We even used a few of the same shapes, in almost the same colors. Can you find the similarities?



On the next page, I've copied the Falling Blocks illustration from the cover of this booklet, along with the template I used to create it. I made the template lines visible in the final image. Can you figure out how I built each shape?

Finally, you might be interested in how geometric tessellations show up in history. Visit Alex Bellos's article [Muslim Rule and Compass: The Magic of Islamic Geometric Design](#) to discover what kind of design Islamic artists created with the first template (on page four of this preview).

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**PREVIEW**