MiNI BLUEBIRD MATH CIRCLE

Issue 6: Fair and Square

Share your problems, solutions, models, stories, and art:
https://akademia.mini.pw.edu.pl/pl/ukraina

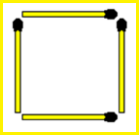
If anything at all, perfection is finally attained not when there is no longer anything to add, but when there is no longer anything to take away.

—Maria Tallchief,
Osage family name: Ki He Kah Stah Tsa,
America's first major prima ballerina

NEWSFLASH

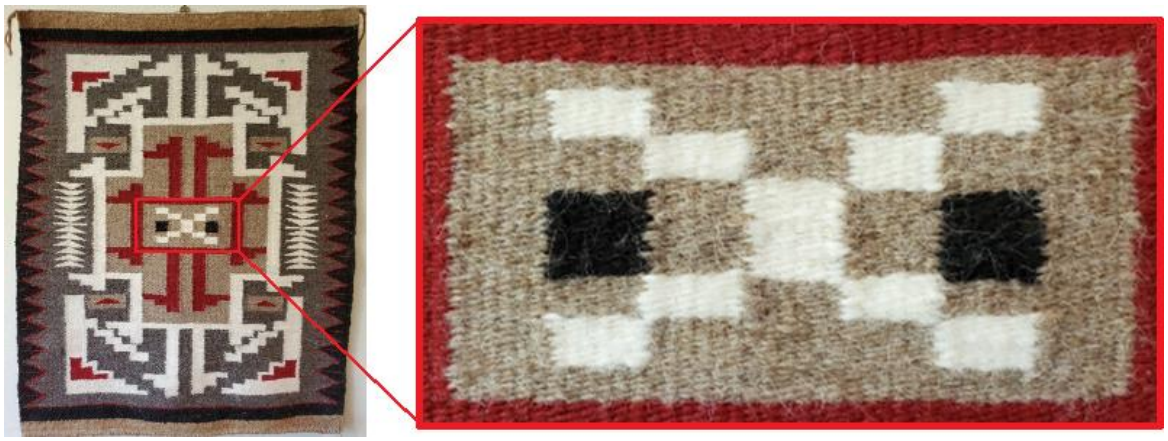
Join LIVE the MiNI Bluebird Math Circle to work on these activities together with friends and family. The math circle is in English and Ukrainian with live translation.
Monday October 17th, 18:30-20:00 Warsaw, Poland time, online.
Sign up at https://akademia.mini.pw.edu.pl/pl/ukraina

MATH PUZZLE



Move one matchstick to create a different square

Inspiration: Native American Art

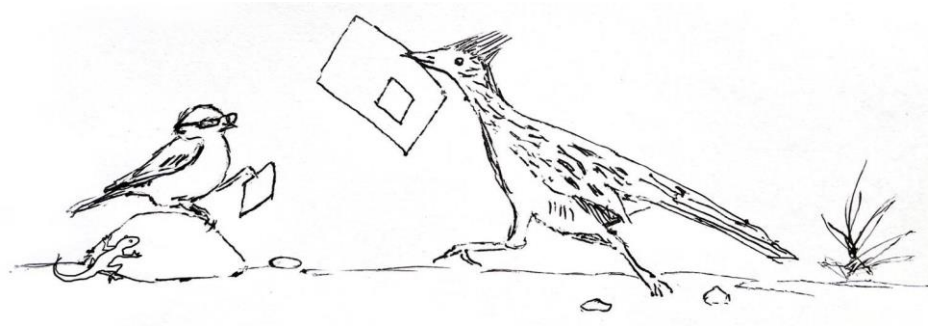


Navajo rug made by Sally Fowler

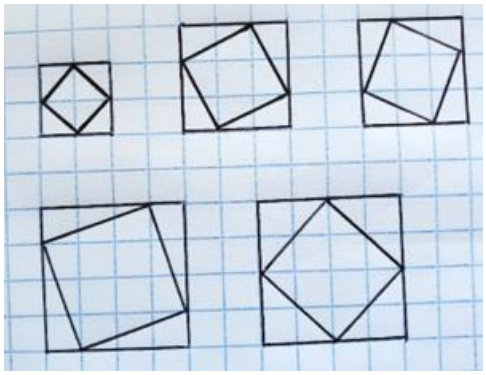
What shapes do you see in the center of the rug?

Warm-Up Activities

1. One nice summer afternoon Bluebird came to see his friend Roadrunner and was greeted with a question. For his handicraft project, Roadrunner needed a perfect square made of cardboard. He had taken a piece of cardboard and cut out the desired shape. Now he had the cardboard with a hole in it and the cut-out piece, and he wanted to verify that the piece was indeed a square, but there were no tools whatsoever – neither a ruler, nor a compass, nor anything else. Bluebird solved the problem! Can you solve it, too?



2. The area of each grid square is 1. Find the area of the inner shape in each of the pictures below. What are these figures?

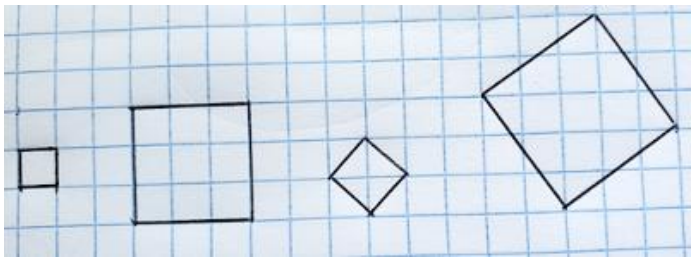


Family Circle: Let's Count!

Let's do something simple and easy. What can be easier than counting, and what can be simpler than a square? So let's count squares in the grid paper.

We'll count two types of squares:

- Squares whose sides lie on grid lines. For convenience, we'll call these *regular* squares.
- Squares whose vertices lie at the intersections of grid lines but whose sides are not on grid lines. We'll call these *tilted* squares.



Examples of regular 1-by-1 and 3-by-3 and two tilted squares

1. Start with a 1-by-1 grid. How many regular squares are there? How many tilted squares? What is the total number of squares?
2. Now let's go to a 2-by-2 grid. How many regular squares are there? How many tilted squares? What is the total number of squares?
3. Now consider a 3-by-3 grid. How many regular squares are there? How many tilted squares? What is the total number of squares?

Did you notice any patterns? Can you predict how many tilted squares a 4-by-4 grid will contain? How many regular squares?

What about a 7-by-7 grid? And if you are into algebra, how many regular and tilted squares does an n-by-n grid contain?

Ask Bluebird

QUESTION—*Where is the guy who put letters in math so I can pick a bone with him?* - from Luke A.

BLUEBIRD SAYS—It would be quite hard to pick a bone with someone who lived almost 2000 years ago! It was Diophantus, often called the Father of Algebra. He lived in Alexandria, in Roman Egypt, in either 1st, 2nd, or 3rd century CE. In his treatise called *Arithmetica* he used letters to denote unknowns, and he described methods to solve algebraic equations.

That's one algebra supervillain we know. Similar dastardly schemes came up in many different places around the world. Maybe because all human languages sort of use variables or unknowns? "Cat" in English, "แมว" in Thai, and "Mósí" in Navajo can mean any feline at all. Likewise, a letter in the language of mathematics can mean an unknown number or many numbers. As you can imagine, over the years world cultures developed elaborate traditions for their math letters. For example, *x* often stands for an unknown we are hunting: "Who is the mysterious mister *x*?" In the famous formula $e = mc^2$, m stands for "mass." The symbol π has been on the most-wanted lists around the world for thousands of years, and has its own holiday on 3/14.

FUN FACT OF THE FORTNIGHT In 1997, Stan Wagon, a mathematics professor at Macalester College in St. Paul, Minnesota designed a square-wheeled bike that can roll smoothly on evenly spaced bumps of a special shape, known as an inverted catenary. A catenary is the curve that a rope or chain forms when you hold the ends in two hands and let it dangle. Campers like tents with a 'catenary cut'. That way the canvas clings to the rope it hangs from better than if the cut is straight. And overhead railroad wires are called 'catenaries', after the curve they follow.

Image by Stan Wagon, Macalester College

The idea might actually be an old one: Near some ancient pyramids in Egypt various pieces of wood cut into quarter-circles have been found. One theory is that they were used so that large blocks of marble with square cross-sections could be easily rolled. Indeed, a quarter-circle is close enough to a catenary that this would work.

Nowadays people can ride Wagon's bike in many places, including the National Museum of Mathematics (MoMath) in New York City. Watch a ride at **https://youtu.be/LgbWu8zJubo**